ICSE

2027

NODIA

PHYSICS

CHAPTERWISE QUESTION BANK

21 Years (2026-2006) Solved Exam Papers

Class 10

Nodia

Scan QR for Demo PDF

GET ALL STUDY MATERIAL IN ONE APP!

- Textbooks
- Previous Year Chapterwise Question Banks
- 30 Sets Sample Papers
- Worksheets

FREE!

DOWNLOAD NOW!

SCAN & DOWNLOAD

GET IT ON Google Play

ICSE 2027

PHYSICS

Including Case Based Questions

CLASS 10

Chapter-wise Question Bank

Based on Previous 21 Year 55 Papers

NODIA

Downloaded from www.pdf.tube

ICSE Class 10 Physics Question Bank
Edition March 2026
Published by : NODIA
An Imprint of NODIA EDITIONS LLP

Information contained in this book has been obtained by author, from sources believes to be reliable. However, neither NODIA nor its author guarantee the accuracy or completeness of any information herein and NODIA nor its author shall be responsible for any error, omissions, or damages arising out of use of this information. This book is published with the understanding that NODIA and its author are supplying information but are not attempting to render engineering or other professional services.

© NODIA EDITIONS LLP

NODIA

MRP Rs 470.00

Now Available at
amazon.com

This book is available on amazon and flipkart only and not available in market.

NODIA EDITIONS LLP
125, Sector 6, Vidyadhar Nagar, Jaipur 302039
Phone :+91 9024037387
email : mail@nodia.in

CONTENTS

	ICSE Examination Paper 2026	5-14
	ICSE Examination Paper 2025	15-24
CHAP 1.	Force : Turning Forces and Uniform Circular Motion	25-66
CHAP 2.	Work, Power and Energy	67-115
CHAP 3.	Mechanics	116-155
CHAP 4.	Light	156-239
CHAP 5.	Sound	240-282
CHAP 6.	Electricity and Magnetism	283-386
CHAP 7.	Heat	387-425
CHAP 8.	Modern Physics	426-458

****

Click Here to Buy book on Amazon

NODIA

NODIA APP

Free PDF For All Study Material

Search Play Store by NODIA

ICSE CLASS X EXAMINATION PAPER 2026

PHYSICS

SCIENCE PAPER - 1

Time: 2 Hours **Max. Marks: 80**

General Instructions:

1. Answer to this Paper must be written on the paper provided separately.
2. You will not be allowed to write during first 15 minutes.
3. This time is to be spent in reading the question paper.
4. The time given at the head of this Paper is the time allowed for writing the answers.
5. Section A is compulsory. Attempt any four questions from Section B.
6. The intended marks for questions or parts of questions are given in brackets [ ].

SECTION-A

(Attempt all questions from this section)

QUESTION 1.

Choose the correct answers to the questions from the given options.
(Do not copy the questions, write the correct answers only.)

(i) For a body to be in dynamic equilibrium, its:
(a) momentum should be zero
(b) acceleration should be zero
(c) kinetic energy should be zero
(d) velocity should be zero

Ans :

(b) acceleration should be zero
Dynamic equilibrium occurs when all forces acting on a body are balanced, resulting in zero net force. According to Newton's laws, zero net force means zero acceleration. The body may still move with constant velocity, so its velocity, momentum, and kinetic energy are not necessarily zero.

(ii) The energy transformation taking place during photosynthesis in plants is:
(a) heat to chemical
(b) chemical to light
(c) light to chemical
(d) chemical to heat

Ans :

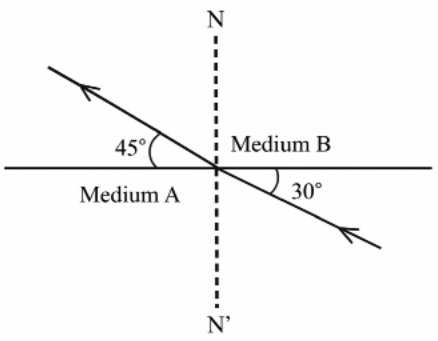
(c) light to chemical
During photosynthesis, green plants use chlorophyll to absorb sunlight. This light energy is converted into chemical energy stored in glucose molecules formed from carbon dioxide and water. The stored chemical energy is later used by plants for growth, respiration and other metabolic activities.

(iii) The Velocity Ratio (VR) of a block and tackle system of two pulleys with the effort in the upward direction is:
(a) 1 (b) 2
(c) 3 (d) 4

Ans :

(b) 2
In a block and tackle system, the velocity ratio equals the number of rope segments supporting the load. For a system with two pulleys and effort applied upward, there are two supporting strands. Hence the load moves half the distance moved by the effort, giving a velocity ratio of two.

(iv) From the figure given below, the refractive index of medium B with respect to medium $({}_{A}\mu_{B})$ A is:



(a) $\frac{\sin 45^\circ}{\sin 30^\circ}$ (b) $\frac{\sin 30^\circ}{\sin 45^\circ}$
(c) $\frac{\sin 45^\circ}{\sin 60^\circ}$ (d) $\frac{\sin 60^\circ}{\sin 45^\circ}$

Ans :

Downloaded from www.pdf.tube

(b) $\frac{\sin 30^\circ}{\sin 45^\circ}$

Using Snell's law, the refractive index of medium A with respect to medium B equals the ratio of the sine of the angle in medium B to the sine of the angle in medium A. From the figure, the angles are 30° and 45°. Therefore ${}_A\mu_B$ = sin 30° divided by sin 45°.

(v) When a blackened bulb thermometer is moved beyond the red region of the visible spectrum, there is a rapid rise in temperature. This is due to the presence of:
(a) Infrared radiations
(b) Ultraviolet radiations
(c) X-rays
(d) Radio waves

Ans :

(a) Infrared radiations
Beyond the red end of the visible spectrum lies the infrared region. Infrared radiations carry heat energy and are not visible to the human eye. When a blackened thermometer is placed in this region, it absorbs these radiations efficiently, causing its temperature to rise rapidly.

(vi) A fast-moving cyclist stops pedalling on reaching a hilly track. If he continues to move with the acquired energy, assuming no loss of energy:
(a) his kinetic energy remains constant at all times.
(b) his potential energy remains constant at all times.
(c) his total mechanical energy continuously increases.
(d) his total mechanical energy remains constant.

Ans :

(d) his total mechanical energy remains constant.
When the cyclist moves uphill without pedalling and no energy is lost, his kinetic energy gradually converts into potential energy. Although kinetic energy decreases and potential energy increases, their total remains unchanged. Therefore, according to the law of conservation of energy, total mechanical energy stays constant.

(vii) The distance (V) of a virtual image formed by a lens of focal length 15 cm never exceed a certain finite value, then this value will be:
(a) less than 15 cm
(b) between 15 cm to 30 cm
(c) less than or equal to 30 cm
(d) less than or equal to 15 cm

Ans :

(d) less than or equal to 15 cm
A virtual image formed by a convex lens occurs when the object is placed between the optical centre and the focus. The image distance in this case is always less than or equal to the focal length of the lens. Therefore, for a focal length of 15 cm, the image distance cannot exceed 15 cm.

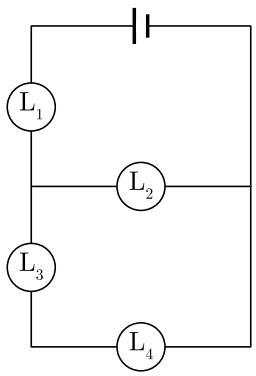
NODIA

(viii) **Assertion (A) :** Tiny air molecules scatter blue light more than red light.
Reason (R) : The refractive index of a medium is greater for blue light than red light.
(a) (A) is true but (R) is false.
(b) (A) is false but (R) is true.
(c) Both (A) and (R) are true and (R) is the correct explanation of (A).
(d) Both (A) and (R) are true but (R) is not the correct explanation of (A).

Ans :

(d) Both (A) and (R) are true but (R) is not the correct explanation of (A).
Tiny air molecules scatter shorter wavelength light more effectively than longer wavelengths. Blue light has a shorter wavelength than red light, so it is scattered more strongly in the atmosphere. Although refractive index is slightly higher for blue light, scattering mainly depends on wavelength, not refractive index.

(ix) In the circuit given below, identify the lamp (L_1, L_2, L_3 or L_4) whose failure would not interrupt the power supply to the other lamps.



(a) L_1 (b) L_2
(c) L_3 (d) L_4

Ans :

(b) L_2

In the given circuit, lamp L_2 is connected in a separate branch between the two sides of the circuit, making it a parallel connection with the other lamps. If L_2 fails, the main circuit path remains complete. Therefore, current can still flow through the other lamps without interruption.

(x) Equal volumes of water are added to three cylindrical jars A, B and C of same height and radii r_A, r_B and r_C respectively with $r_B < r_A < r_C$. If you blow air into the mouth of these jars, which tube will produce the shrillest note?

(a) A
(b) B
(c) C
(d) All will produce the notes of same shrillness

Ans :

(c) C
When air is blown across the mouth of jars, the pitch depends on the length of the air column above the water. For equal volumes of water, the jar with the largest radius has the smallest water height, leaving the longest air column. A longer air column produces a higher frequency sound, giving the shrillest note.

(xi) A metallic wire is stretched in such a way that its new length becomes twice the original length. How does its specific heat capacity change?

(a) becomes double
(b) becomes 4 times
(c) becomes ¼
(d) remains the same

Ans :

(d) remains the same
Specific heat capacity is a property of the material itself and does not depend on the shape, length, or size of the object. Stretching the wire changes its dimensions but not the nature of the material. Therefore, the specific heat capacity of the wire remains unchanged.

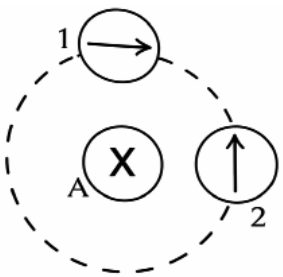
(xii) The correct formula to calculate the equivalent resistance of two resistors R_1 and R_2 when connected in parallel is:

(a) $\frac{R_1 + R_2}{R_1 R_2}$ (b) $\frac{R_1 R_2}{R_1 + R_2}$
(c) $\frac{R_1 - R_2}{R_1 R_2}$ (d) $\frac{R_1 R_2}{R_1 - R_2}$

Ans :

(b) $\frac{R_1 R_2}{R_1 + R_2}$
In a parallel combination, the reciprocal of the equivalent resistance equals the sum of reciprocals of individual resistances. For two resistors, this relation simplifies to . This formula shows that the equivalent resistance is always less than either of the two resistances.

(xiii) The diagram below shows the top view of the wire A shown by a cross (X) carrying current into the plane of the paper. Which of the compasses is correctly aligned with the magnetic field produced by the current carrying wire?



(a) Only 1 is aligned.
(b) Only 2 is aligned.
(c) Both 1 and 2 are aligned.
(d) Both 1 and 2 are not aligned.

Ans :

(a) Only 1 is aligned
When current flows into the plane of the paper, the magnetic field around the wire forms concentric circles in the clockwise direction according to the right-hand thumb rule. A compass aligns tangentially to these field lines. Compass 1 shows the correct tangential direction, while compass 2 does not follow the clockwise field pattern.

(xiv) Three substances A, B and C of same mass are present at their respective melting points. On heating, they melt completely in 5 minutes, 7 minutes and 3 minutes respectively, then which substance has the highest specific latent heat? (Assuming heat is absorbed at the same rate)

(a) Substance A
(b) Substance B
(c) Substance C
(d) All the substances have same specific latent heat

Ans :

(b) Substance B
Latent heat is the heat required to change the state of a substance without changing its temperature. Since the substances have equal

Click Here to Buy book on Amazon

ICSC CLASS 9

Previous Year Solved Exam Question Bank

Click your Subject and Instantly get a free PDF or Order the Hard copy from Amazon.

English Language

English Literature

Physics

Chemistry

Biology

Mathematics

Geography

History and Civics

Economics

Commercial Studies

Environmental Science

Physical Education

Computer Application

Economics Application

Commercial Application

Environ. Application

Home Science

Hindi

Robotics and AI

Yoga

For Other Subject PDF of all Classes, and for NEET, JEE and CUET visit

www.pdf.tube

ICSC CLASS 10

Previous Year Solved Exam Question Bank

Click your Subject and Instantly get a free PDF or Order the Hard copy from Amazon.

English Language	English Literature	Physics	Chemistry
Biology	Mathematics	Geography	History and Civics
Economics	Commercial Studies	Environmental Science	Physical Education
Computer Application	Economics Application	Commercial Application	Environ. Application
Home Science	Hindi	Robotics and AI	Yoga

BUY IT ON amazon

DOWNLOAD FREE PDF WWW.MCQGPT.COM

For Other Subject PDF of all Classes, and for NEET, JEE and CUET visit

www.pdf.tube

ISC CLASS 11

Previous Year Solved Exam Question Bank

Click your Subject and Instantly get a free PDF or Order the Hard copy from Amazon.

English Com

Mathematics

Physics

Chemistry

Biology

Physical Education

Environmental Science

Computer Science

Accountancy

Business Studies

Economics

Commerce

Legal Studies

Mass Media

Home Science

History

Geography

Political Science

Psychology

Sociology

For Other Subject of All Clasess PDF and for NEET, JEE and CUET visit

www.pdf.tube

ISC CLASS 12

Previous Year Solved Exam Question Bank

Click your Subject and Instantly get a free PDF or Order the Hard copy from Amazon.

English Com

Mathematics

Physics

Chemistry

Biology

Physical Education

Environmental Science

Computer Science

Accountancy

Business Studies

Economics

Commerce

Legal Studies

Mass Media

Home Science

History

Geography

Political Science

Psychology

Sociology

For Other Subject of All Clasess PDF and for NEET, JEE and CUET visit

www.pdf.tube

masses and absorb heat at the same rate, the one taking the longest time to melt requires the most heat. Substance B melts in seven minutes, so it has the highest specific latent heat.

(xv) An atom of lithium contains 3 electrons, 3 protons and 4 neutrons. Its mass number is:
(a) 3 (b) 4
(c) 7 (d) 10

Ans :

(c) 7
The mass number of an atom is the total number of protons and neutrons present in its nucleus. Electrons are not included because their mass is negligible. Lithium has three protons and four neutrons. Adding them together gives a mass number of seven for the atom.

QUESTION 2.

(i) Complete the following by choosing the correct answers from the bracket:
(a) A car is moving in uniform circular motion. The direction of **friction** between the tyres and the path is _____ [towards the centre/ tangential to the path].
(b) When a ray of light passes from a **denser to a rarer** medium, its wavelength _____ [decreases/increases].
(c) The **lid** of a calorimeter minimises heat loss by _____ [convection/radiation].
(d) **Quality** of sound depends on its _____ [amplitude/waveform].
(e) A substance whose **resistance** becomes almost negligible at a temperature near **absolute zero** is called a _____ [semiconductor/ superconductor].
(f) _____ radiation deviates **minimum** in a magnetic field [Alpha/Beta].

Ans :

(a) towards the centre
(b) increases
(c) convection
(d) waveform
(e) superconductor
(f) Alpha

(ii) State two factors on which the position of Center of Gravity of a body depends.

Ans :

The shape of the body and the distribution of mass in the body.

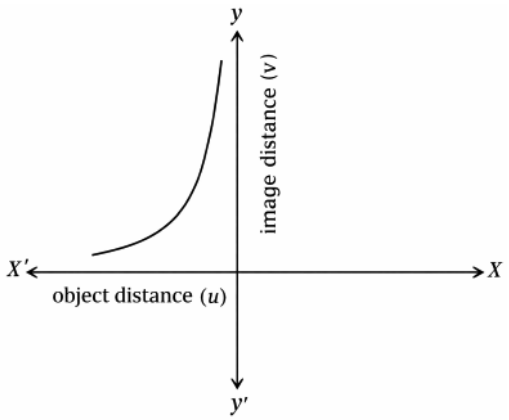
(iii) **Case 1 :** Lata cuts a potato into two halves, using a cutter which belongs to a Class II lever. She needed effort E_1.
Case 2 : Then she cuts one half of this potato again, but this time she needed effort E_2. If $E_1 > E_2$ then:
(a) In which case (1st or 2nd) was the potato closer to her hand applying the effort? (Assume normal reaction of the surface of the potato is same in both case)
(b) Give a reason for your answer in (a) above.

Ans :

(a) 2nd case
(b) According to the principle of moments, when the load is closer to the effort, less effort is required.

QUESTION 3.

(i) The graph below shows the variation of image distance (v) with the object distance (u) when an object is kept in front of a lens.



(a) Identify the type of lens used.
(b) What would be the magnification (more than 1/less than 1/equal to 1) if the object is placed between F and $2F$ of the above lens?

Ans :

(a) Convex lens
(b) More than 1

(ii) A resistance R is connected across a cell with a switch and a rheostat in series. A voltmeter is connected parallel across the cell. Current in the circuit is increased using the rheostat.
(a) How will the voltmeter reading change? (increase/decrease/remain the same)
(b) Justify your answer stated in (a) above.

Downloaded from www.pdf.tube

Ans :

(a) Remain the same.
(b) The voltmeter is connected in parallel across the cell, so it measures the potential difference of the cell which remains constant.

(iii) (a) Define natural vibrations.
(b) How is this vibration different from damped vibrations in terms of their amplitudes?

Ans :

(a) Natural vibrations are the vibrations of a body that occur when it vibrates freely at its own natural frequency without any external force.
(b) In natural vibrations the amplitude remains constant, while in damped vibrations the amplitude gradually decreases with time.

(iv) A metal piece of thermal capacity 40 JK^{-1}, absorbs 800 J of heat. Calculate the rise in the temperature of this metal piece.

Ans :

Given, Thermal capacity = 40 JK^{-1}

$$\Delta T = \frac{Q}{C}$$
$$= \frac{800}{40}$$
$$= 20 \text{ K}$$

(v) In an AC generator, name the part which has the following functions:
(a) intensifies the magnetic field.
(b) maintains electrical contact between the rotating parts and the external circuit.

Ans :

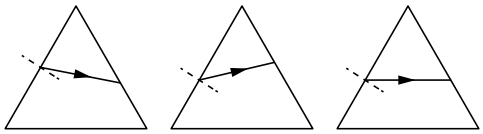
(a) Soft iron core.
(b) Carbon brushes.

(vi) Give two differences between nuclear fission and nuclear fusion.

Ans :

Nuclear fission is the splitting of a heavy nucleus into two lighter nuclei, whereas nuclear fusion is the combining of two light nuclei to form a heavier nucleus.
Nuclear fission occurs at comparatively lower temperatures, whereas nuclear fusion requires extremely high temperature and pressure.

(vii) A monochromatic ray strikes the surface of identical prisms (A, B and C) at different angles of incidence. The diagram below shows their refracted rays. Study the path of these refracted rays and identify in which of the diagrams:



(a) the angle of incidence is maximum.
(b) the angle of incidence is minimum.
(c) the angle of incidence is equal to the angle of emergence.

Ans :

(a) A
(b) C
(c) B

SECTION B

(Attempt any four questions from this section)

QUESTION 4.

(i) A ray of light enters a glass block from air and comes out from the opposite surface. If the angle of refraction at the first surface is not the same as the angle of incidence at the second surface, then:
(a) What is the product of the ratio $\frac{\sin i}{\sin r}$ at the first surface and at the second surface?
(b) State whether the opposite surfaces are parallel or not parallel.
(c) How did you reach the conclusion in (b) above?

Ans :

(a) 1
(b) Parallel
(c) Because the product of the ratios equals 1, which occurs only when the refracting surfaces are parallel.

(ii) A type of glass block has a refractive index of 1.8
(a) Calculate the speed of light in this glass. (Given speed of light in air $= 3 \times 10^8 \text{ ms}^{-1}$)
(b) If the width of this block is doubled, then what will be the speed of light in the block?

Ans :

(a)

Given,
Refractive index of glass,

NODIA

$$n = 1.8$$

Speed of light in air,

$$c = 3 \times 10^8 \text{ ms}^{-1}$$

$$v = \frac{c}{n}$$

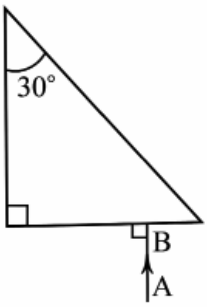
$$= \frac{3 \times 10^8}{1.8}$$

$$= 1.67 \times 10^8 \text{ ms}^{-1}$$

(b) The speed of light in a medium depends only on the refractive index, not on the width or thickness of the material. Since the refractive index remains 1.8, the speed does not change i.e. $1.67 \times 10^8 \text{ ms}^{-1}$.

(iii) (a) Name the electromagnetic radiation used to detect fake currency.

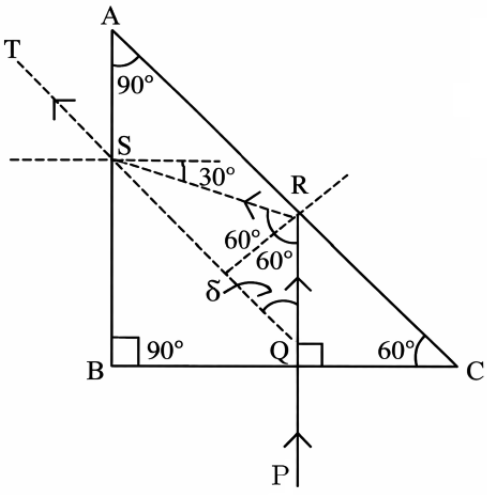
(b) Redraw the diagram given below and complete the path of the light ray AB through the glass prism till it emerges out of the prism. Critical angle of the glass is 42°.



Ans :

(a) Ultraviolet rays

(b)



QUESTION 5.

(i) An object placed in front of a convex lens forms an image of the same size on a screen. Moving the object 12 cm closer to the lens results in the formation of a real image which is three times the size of the object.
Calculate the focal length of the lens.

Ans :

For same size image:

$$u = 2f$$

Object moved 12 cm closer:

$$u = 2f - 12$$

Magnification $m = 3$

$$m = \frac{v}{u}$$

$$= 3$$

Using lens formula:

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$v = 3u$$

$$\frac{1}{f} = \frac{1}{3u} + \frac{1}{u}$$

$$= \frac{4}{3u}$$

$$f = \frac{3u}{4}$$

Substitute $u = 2f - 12$

$$f = \frac{3(2f - 12)}{4}$$

$$4f = 6f - 36$$

$$2f = 36f$$

$$= 18 \text{ cm}$$

Focal length = 18 cm

(ii) (a) Atmospheric temperature after a hailstorm is greater than the temperature during the hailstorm. State True or False.

(b) Which thermal physical quantity of a frying pan changes by making its base heavier?

(c) State the principle of Calorimetry.

Ans :

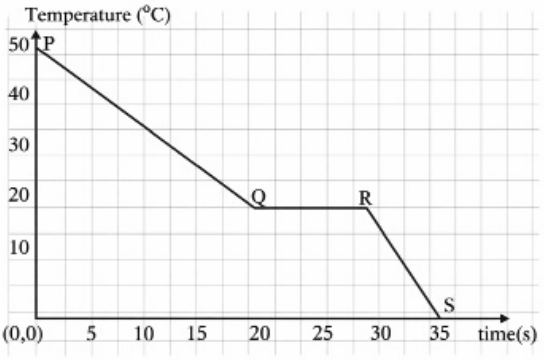
(a) True

(b) Thermal capacity

(c) In an isolated system, the heat lost by the hot body is equal to the heat gained by the cold body until thermal equilibrium is reached, provided no heat is lost to the surroundings.

Click Here to Buy book on Amazon

(iii) The given graph represents the cooling curve of a liquid.



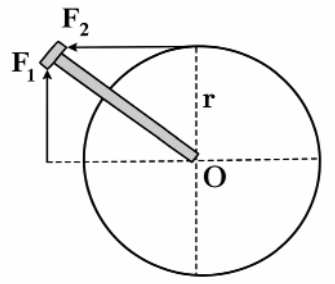
(a) State the freezing temperature of the liquid.
(b) Name the phase change happening at the region QR.
(c) In which state (solid/liquid) does the above substance liberate at a faster rate? Justify.

Ans :

(a) 20°C
(b) Freezing (liquid to solid)
(c) Solid state.

QUESTION 6.

(i) The diagram shows a wheel with a handle Two forces, F_1 and F_2 of equal magnitudes are acting on the handle as shown in the diagram.

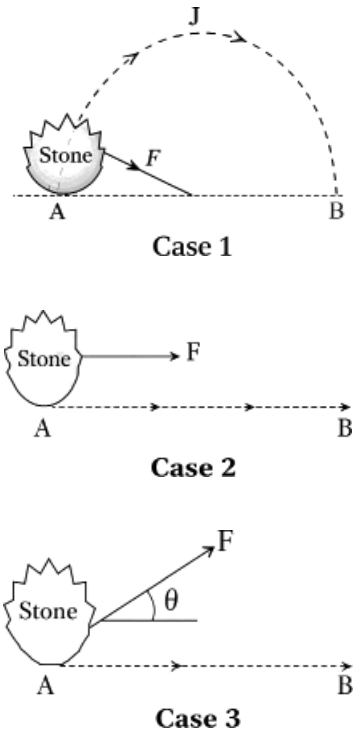


(a) Which force produces negative moment?
(b) Is the wheel in equilibrium? (Yes or No)
(c) Justify your answer stated in (b).

Ans :

(a) F_1
(b) No
(c) The wheel is not in equilibrium because the clockwise moment and anticlockwise moment are not balanced. Since the sum of moments about point O is not zero, the wheel will rotate.

(ii) (a) Name the unit of work done, used in subatomic scale.
(b) To which class of lever does a pair of scissors belong?
(c) A stone is tied to a string and displaced from A to B by application constant force F in three different ways as shown in the diagram below. Arrange the three cases in ascending order of the work done by the force.
(Given AJB is a semi-circle, $\theta < 90^\circ$ and $AB = 20$ m)



Ans :

(a) Electron volt (eV)
(b) First class lever
(c) Case 3 < Case 1 < Case 2

(iii) A ball of mass **20 g** falls from a height of **45 m**. It rebounds from the ground to a height of **40 m**. Calculate :
(a) the initial potential energy of the ball.
(b) the speed of the ball when it hits the ground.
(c) the loss in kinetic energy on striking the ground.
[g = 10 m/s^2]

Ans :

(a) Mass

$$m = 20 \text{ g} = 0.02 \text{ kg}$$

$$PE = mgh$$

$= 0.02 \times 10 \times 45$

$= 9$ J

(b) $v = \sqrt{2gh}$

$= \sqrt{2 \times 10 \times 45}$

$= \sqrt{900}$

$= 30$ m/s

(c) K.E before hitting ground

$= mgh = 0.02 \times 10 \times 45$

$=9$ J

K.E after rebound

$= mgh = 0.02 \times 10 \times 40$

$= 8$ J

Loss in K.E $= 9 - 8$

$= 1$ J

QUESTION 7.

(i) To lift a load of 30 kgf. Suhas uses a single fixed pulley, while Radha uses a single movable pulley. The displacement of efforts in both the cases are equal. In an ideal situation calculate the ratio of:
(a) the efforts in the two cases.
(b) the potential energy gained by the loads in the two cases.
(c) the efficiencies in the two cases.

Ans :

(a) For Single fixed pulley
Mechanical Advantage MA = 1

Effort = Load = 30 kgf

For Single movable pulley
Mechanical Advantage MA = 2

$\text{Effort} = \frac{30}{2} = 15$ kgf

Ratio of efforts

$30 : 15 = 2 : 1$

(b) Potential energy gained depends on load × height lifted. Since the displacement of efforts is equal, the load in both cases rises through the same vertical height. Thus both loads gain the same potential energy, 1 : 1.

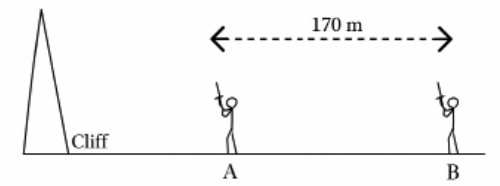
(c) Both pulleys have the same efficiency, 100%.

(ii) (a) One end of a plastic foot ruler is held tightly at the edge of a table and the other end is plucked. Name the vibrations produced in the ruler.
(b) Now the ruler is pushed inside partially and plucked again from its from end. State with a reason whether the frequency of vibration increases decreases.

Ans :

(a) Natural vibrations
(b) Frequency increases, The vibrating length of the ruler decreases, so the frequency of vibration increases.

(iii) Two persons A and B are standing in front of a cliff in the same line 170 m apart as shown in the diagram. Person B fires the gun and hears the echo in 3 s. Then the person A standing in front of the person B fires the gun.
(The speed of sound in air is 340 m/s.)



(a) Calculate
(i) the distance of person B from the cliff.
(ii) the minimum time in which B hears the gunshot fired by A.

(b) Fill in the blank:
The echo is softer (less loud) than the original sound due to the decrease in _____ of the wave. (amplitude/frequency)

Ans :

(a) (i) Time for echo = 3 s
Distance travelled by sound $= v \times t$

$= 340 \times 3 = 1020$ m

Since sound travels to the cliff and back,

$2d = 1020$

$d = 510$ m

(ii) Distance between A and B = 170 m

$t = \frac{d}{v}$

$= \frac{170}{340}$

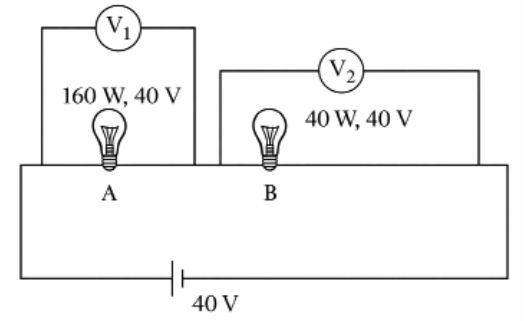
$= 0.5$ s

(b) amplitude

QUESTION 8.

(i) Bulb A rated 160 W, 40 V and Bulb B rated 40 W, 40 V are connected as shown in the diagram.

Downloaded from www.pdf.tube



(a) Calculate the ratio $V_1 : V_2$
(b) If bulb A fuses, the current in the circuit remains the same. State True or False.

Ans :

(a) Resistance of bulb A

$$R_A = \frac{V^2}{P}$$

$$= \frac{40^2}{160} = 10\ \Omega$$

Resistance of bulb B

$$R_B = \frac{40^2}{40} = 40\ \Omega$$

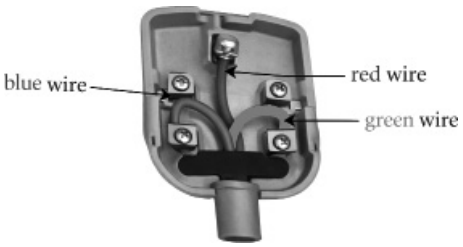
In series circuit, voltage divides in the ratio of resistances

$$V_1 : V_2 = R_A : R_B$$

$$10 : 40 = 1 : 4$$

(b) False, If bulb A fuses, the circuit becomes open, so no current flows.

(ii) The reverse side of a three-pin plug with incorrect connection of wires is shown in the diagram below.

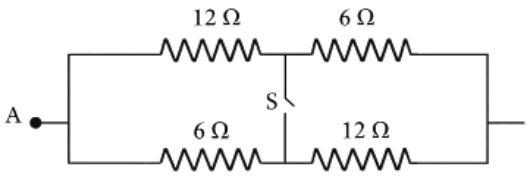


(a) Identify the fault in the above connection.
(b) Mention a risk factor involved if the user operates the appliance without correcting it.
(c) Will the appliance function in the present situation? (Yes or No)

Ans :

(a) The earth wire (green wire) is connected to a wrong terminal instead of the top earth terminal.
(b) Risk of electric shock.
(c) No

(iii) In the combinations of resistors shown below, calculate:



(a) The resistance across AB when the switch S is open
(b) The resistance across AB when the switch S is closed

Ans :

(a) Top branch resistance

$$12\ \Omega + 6\ \Omega = 18\ \Omega$$

Bottom branch resistance

$$6\ \Omega + 12\ \Omega = 18\ \Omega$$

Since both branches are connected in parallel, the equivalent resistance is given by:

$$R = \frac{18 \times 18}{18 + 18}$$

$$= \frac{324}{36} = 9\ \Omega$$

(b) 12 Ω (top) in parallel with 6 Ω (bottom), the equivalent resistance is given by:

$$R_1 = \frac{12 \times 6}{12 + 6} = 4\ \Omega$$

Similarly 6 Ω (top) in parallel with 12 Ω (bottom), the equivalent resistance is given by:

$$R_2 = \frac{12 \times 6}{12 + 6} = 4\ \Omega$$

These two equivalent resistances (R_1 and R_2) are in series. The equivalent resistance between A and B is given by:

$$R_{AB} = 4 + 4$$

$$= 8\ \Omega$$

NODIA

QUESTION 9.

(i) An electric iron rated **1100 W, 220 V** is operated for **5 hours**. Calculate
(a) the minimum rating of the fuse required.
(b) the energy consumed in kWh.
(c) the cost of energy consumed if the rate is ₹10 per unit.

Ans :

(a) Minimum rating of the fuse

$$I = \frac{P}{V}$$

$$= \frac{1100}{220}$$

$$= 5 \text{ A}$$

Minimum fuse rating = 5 A

(b) Power, $P = 1100 \text{ W} = 1.1 \text{ kW}$

Time, $t = 5 \text{ h}$

Energy $= P \times t$

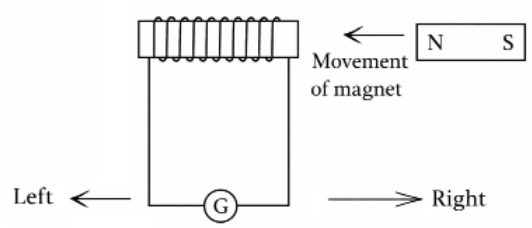
$= 1.1 \times 5$

$= 5.5 \text{ kWh}$

(c) Cost $= 5.5 \times 10$

$= ₹5.50$

(ii) When the magnet as shown in the diagram, is moved towards the coil at a speed of 5 ms^{-1}, the galvanometer shows a certain deflection to the right.



How will the direction and magnitude of deflection change when the coil also moves with a speed of 5 ms^{-1}.

(a) in the direction of the motion of the magnet?

(b) in the opposite direction of the motion of the magnet?

Ans :

(a) Deflection becomes zero.

(b) Deflection remains to the right but increases in magnitude.

(iii) (a) 1. Which element is used in the lining of the special aprons worn by workers in nuclear power plants?

2. Why is this element preferred?

(b) $^{24}_{11}Na$ emits a nuclear radiation which does not alter the mass number is deflected by a magnetic field.

1. Name the type of nuclear radiation emitted by $^{24}_{11}Na$.

2. Write the equation for this radioactive decay.

Ans :

(a) 1. Lead

2. Because lead absorbs harmful nuclear radiations due to its high density.

(b) 1. Beta (β) radiation

2. $^{24}_{11}Na \rightarrow {}^{24}_{12}Mg + {}^{0}_{-1}\beta$

www.nodia.in

Click Here to Buy book on Amazon

ICSE CLASS X EXAMINATION PAPER 2025

PHYSICS

SCIENCE PAPER - 1

Time: 2 Hours **Max. Marks: 80**

General Instructions:

1. Answer to this Paper must be written on the paper provided separately.
2. You will not be allowed to write during first 15 minutes.
3. This time is to be spent in reading the question paper.
4. The time given at the head of this Paper is the time allowed for writing the answers.
5. Section A is compulsory. Attempt any four questions from Section B.

NODIA

SECTION-A

QUESTION 1.

Choose the correct answers to the questions from the given options.

(i) A body is acted upon by two equal and opposite forces, that are NOT along the same straight line. The body will:
(a) remain stationary
(b) have only rotational motion
(c) have only rectilinear motion
(d) have both rectilinear and rotational motion

Sol :

When two equal and opposite forces act on a body but are not aligned along the same straight line, they form what is called a couple. A couple creates a torque or moment of force, which causes the body to rotate. Since the forces are equal and opposite, there is no net force acting on the body, meaning there will be no rectilinear (straight-line) motion. However, the torque generated by the couple will cause the body to undergo rotational motion. This is a fundamental concept in mechanics, where the absence of a net force but the presence of a net torque leads to pure rotation.
Thus (b) is correct option.

(ii) Which among the following is a vector quantity?
(a) work (b) power
(c) energy (d) moment of couple

Sol :

A vector quantity is defined as a physical quantity that has both magnitude and direction. The moment of a couple (also called torque) is a vector quantity because it has both a magnitude (the product of force and the perpendicular distance between the forces) and a specific direction (the axis of rotation, determined by the right-hand rule). In contrast, work, power, and energy are scalar quantities because they only have magnitude and no specific direction. For example, work is the dot product of force and displacement, which results in a scalar value.
Thus (d) is correct option.

(iii) What is the correct energy transformation during burning of a candle?
(a) heat $\longrightarrow$ kinetic + potential
(b) heat $\longrightarrow$ chemical + light
(c) chemical $\longrightarrow$ heat + light
(d) mechanical $\longrightarrow$ chemical + heat

Sol :

When a candle burns, the chemical energy stored in the wax (which is a hydrocarbon) is released through a combustion reaction. This chemical reaction involves the wax reacting with oxygen in the air to produce carbon dioxide, water vapor and energy. The energy is released in the form of heat and light. This is an example of an exothermic reaction, where energy is released to the surroundings. The heat warms the environment, and the light illuminates the area. Thus, the energy transformation is from chemical energy to heat and light energy.
Thus (c) is correct option.

(iv) When a ray of light passes from one optical medium to another, which of the following physical quantities does not change?
(a) Amplitude of the wave
(b) Frequency of the wave
(c) Wavelength of the wave
(d) Speed of the wave

Sol :

When light travels from one medium to another (e.g., from air to glass), its speed and wavelength change due to the difference in the refractive indices of the two media. However, the frequency of the light wave remains constant. This is because the frequency is determined by the source

of the light and is independent of the medium through which the light travels. The relationship between speed (v), wavelength (λ) and frequency (f) is given by the equation $v = \lambda$. Since the frequency (f) remains unchanged, the change in speed (v) is compensated by a change in wavelength (λ).
Thus (b) is correct option.

(v) Which one of the following combinations is the correct ascending order of electromagnetic waves in terms of wavelength?
(a) gamma-rays, visible light, microwaves
(b) microwaves, visible light, gamma-rays
(c) gamma-rays, microwaves, visible light
(d) microwaves, gamma-rays, visible light

Sol :

Electromagnetic waves are arranged in the electromagnetic spectrum based on their wavelengths or frequencies. The correct ascending order of electromagnetic waves in terms of wavelength (from shortest to longest) is:
1. Gamma-rays (shortest wavelength, highest frequency).
2. X-rays.
3. Ultraviolet light
4. Visible light
5. Infrared light
6. Microwaves
7. Radio waves (longest wavelength, lowest frequency)

Thus, the correct order is gamma-rays → visible light → microwaves. Gamma-rays have the shortest wavelength, visible light has a medium wavelength, and microwaves have a longer wavelength.
Thus (a) is correct option.

(vi) For a lever, a graph is plotted with load on Y-axis and effort on X-axis. Which of the following represents the slope of the graph?
(a) Mechanical advantage
(b) Velocity ratio
(c) 1/Velocity ratio
(d) 1/Mechanical advantage

Sol :

In a lever system, the mechanical advantage (MA) is defined as the ratio of the load (output force) to the effort (input force). Mathematically, $MA = \frac{\text{Load}}{\text{Effort}}$. If a graph is plotted with load on the Y-axis and effort on the X-axis, the slope of the graph $\frac{\text{Load}}{\text{Effort}}$ represents the mechanical advantage. A steeper slope indicates a higher mechanical advantage, meaning less effort is required to lift a given load.
Thus (a) is correct option.

(vii) For a real image formed by a convex lens, the ratio of $I : O = 2 : 5$, then the object is:
(a) between O and F
(b) beyond $2F$
(c) at F
(d) between F and $2F$

Sol :

The ratio of the height of the image (I) to the height of the object (O) is called the magnification (m). Here, $m = \frac{I}{O} = \frac{2}{5}$. Since the image is real and formed by a convex lens, the magnification is less than 1 ($m < 1$), which indicates that the image is diminished. For a convex lens, a diminished real image is formed only when the object is placed beyond $2F$ (twice the focal length). If the object were between (F) and ($2F$), the image would be magnified ($m > 1$). If the object were at (F), no real image would form. Thus, the object must be beyond $2F$.
Thus (b) is correct option.

(viii) A ray of light is incident normally on a face of an equilateral prism. The ray gets totally reflected at the second refracting surface. The total deviation produced in the path of the ray is:
(a) 30° (b) 60°
(c) 90° (d) 120°

Sol :

For an equilateral prism, when light is incident normally on one face, it refracts inside the prism and then gets totally internally reflected at the second surface. The total deviation is calculated using the geometry of the prism and is found to be 60°.
Thus (b) is correct option.

(ix) In a closed circuit containing a bulb and a cell, the electromotive force (ε) and the terminal voltage (V) is related as
(Given I is current and r is internal resistance.)
(a) $V = \varepsilon + Ir$
(b) $V = \varepsilon - Ir$
(c) $V = \varepsilon \times Ir$
(d) $V = \varepsilon \div Ir$

Sol :

The terminal voltage of a cell is given by:

$$V = \varepsilon - Ir$$

where I is the current and r is the internal resistance. The internal resistance causes a voltage drop Ir, reducing the terminal voltage from the EMF value.
Thus (b) is correct option.

NODIA

(x) A metal piece of mass 5 g has thermal capacity 2.5 J K^{-1}. If the mass of the metal is tripled, then its specific heat capacity will be:

(a) 7.5 $Jg^{-1}K^{-1}$

(b) 2.5 $Jg^{-1}K^{-1}$

(c) 1.5 $Jg^{-1}K^{-1}$

(d) 0.5 $Jg^{-1}K^{-1}$

Sol :

Thermal capacity is given by:

$$C = mc$$

where m is mass and c is specific heat capacity.

Rearranging,

$$c = \frac{C}{m} = \frac{2.5}{5} = 0.5\ \text{Jg}^{-1}\text{K}^{-1}$$

Since specific heat capacity is independent of mass, it remains the same when mass is tripled.

Thus (d) is correct option.

(xi) **Assertion (A) :** As the level of water in a tall measuring cylinder kept under running tap rises, the pitch of sound gradually increases.

Reason (R) : Frequency of sound is inversely proportional to the length of the water column.

(a) Both (A) and (R) are true and (R) is correct explanation of (A).

(b) Both (A)and (R) are true and (R) is not the correct explanation of (A).

(c) (A)is true but (R) is false.

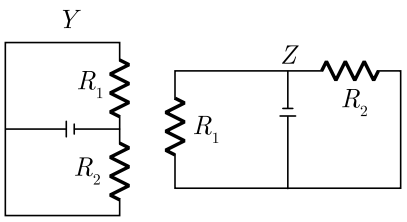
(d) (A)is false but (R) is true.

Sol :

The sound produced in the cylinder is due to resonance of air above the water. As water level rises, the effective air column decreases, causing frequency (pitch) to increase. However, frequency is directly (not inversely) proportional to the length of the air column. So, R is false.

Thus (c) is correct option.

(xii) In the given circuits *Y* and *Z*, the resistors R_1 and R_2 are connected in:



(a) series in both the circuits.

(b) parallel in both the circuits.

(c) parallel in Y and series in Z.

(d) series in Y and parallel in Z.

Sol :

From the given circuit diagrams, the resistors R_1 and R_2 are in parallel configuration in both circuits Y and Z. This means that both resistors share the same voltage but split the current.

Thus (b) is correct option.

(xiii) A radioactive element P emits one α-particle and transforms to a new element Q. What will be the position of the element Q in the periodic table?

(a) One group to the left of P.

(b) One group to the right of P.

(c) Two groups to the left of P.

(d) Two groups to the right of P.

Sol :

Emission of an α-particle (He^{2+}) results in the loss of 2 protons and 4 mass units from the parent element.

Since elements in the periodic table are arranged by atomic number (protons), the new element Q will shift two places to the left in the periodic table.

Thus (c) is correct option.

(xiv) Each of the substances given below is supplied with the same amount of heat. Which one will attain the highest temperature?

Substance	Lead	Aluminium	Copper	Iron
Specific Heat Capacity (cal/g°C)	0.031	0.21	0.095	0.11

(a) Aluminium

(b) Copper

(c) Iron

(d) Lead

Sol :

The temperature rise of a substance when heated is given by the formula:

$$\Delta T = \frac{Q}{mc}$$

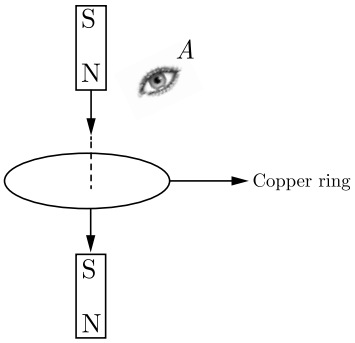
where Q is heat energy, m is mass, and c is the specific heat capacity.

A substance with lower specific heat capacity will attain a higher temperature for the same heat supplied. From the given table, lead has the lowest specific heat capacity (0.031 cal/g°C). Therefore, lead will attain the highest temperature.

Thus (d) is correct option.

(xv) The following figure shows a small bar magnet falling freely through a copper ring. For the observer at A, the direction of the induced current will be:

Downloaded from www.pdf.tube



(a) Clockwise when the magnet is above and below the ring.
(b) Anticlockwise when the magnet is above and below the ring.
(c) Anticlockwise when the magnet is above the ring and clockwise when the magnet is below the ring.
(d) Clockwise when the magnet is above the ring and anticlockwise when the magnet is below the ring.

Sol :

According to Lenz's Law, the induced current in the copper ring opposes the change in magnetic flux.

1. When the magnet is above the ring, its north pole is approaching, causing an increase in downward flux. The induced current in the ring will flow anticlockwise (as seen from A) to oppose this change.
2. When the magnet moves below the ring, the south pole is moving away, causing a decrease in downward flux. To oppose this, the induced current will flow clockwise.
   Thus (c) is correct option.

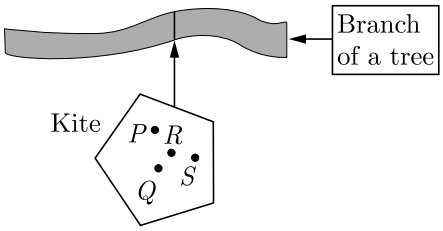
QUESTION 2.

(i) Complete the following by choosing the correct answers from the bracket:
(a) In uniform circular motion, the centrifugal force acts _____[towards the centre / away from the centre / along the tangential direction].
(b) Refractive index of a medium is independent of _____[temperature / angle of incidence / wavelength of light].
(c) Heat absorbed during a change of phase depends on_____ [mass / change in temperature / specific heat capacity].
(d) EMF of a cell is_____[greater than / less than / equal to] the terminal voltage when the cell is in an open circuit.
(e) In a step-up transformer, the turns ratio is_____[more than 1 / less than 1 / equal to 1].
(f) The nuclear radiation with the lowest ionizing power is_____[α / β / γ].

Sol :

(a) Away from the centre
(b) Angle of incidence
(c) Mass
(d) Equal to
(e) More than 1
(f) γ (gamma) rays

(ii) A non-uniform kite is hanging freely from the branch of a tree. Study the figure and answer the following:

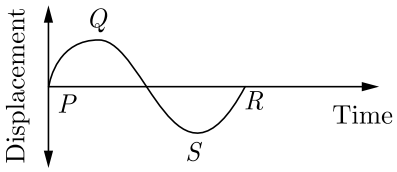


(a) Fill in the blank:_____ (P, Q, R, or S) is the most probable position of its center of gravity.
(b) Support your answer to (a) with a reason.

Sol :

(a) R
(b) When an object is freely suspended, it always comes to rest in a position where its center of gravity is at the lowest possible point. The kite hangs in equilibrium, meaning the net force and torque acting on it are zero. Since *R* is the lowest point, it is the most probable position of the center of gravity.

(iii) The displacement-time graph of a sound wave produced by a vibrating wire is shown below. Answer the following:



(a) How will you adjust the tension in the wire to reduce the length of PR?
(b) Which characteristic of sound is affected by the reduction in the length of PR?

Sol :

(a) To reduce the wavelength (or length PR) of a vibrating wire, we need to increase the tension in the wire. Increasing tension increases the wave speed, leading to a decrease in wavelength.
(b) Reducing PR increases the frequency of the wave, which in turn increases the pitch of the sound. The pitch of a sound wave is directly related to its

NODIA

frequency. Thus, increasing the tension raises the pitch of the sound produced by the vibrating wire.

QUESTION 3.

(i) A ray of light enters a rectangular glass slab submerged in water at an angle of incidence 55°. Does this ray undergo total internal reflection when it moves from water to glass? Justify your answer.

Sol :

No, total internal reflection does not occur.
Total internal reflection only occurs when a wave travels from a medium of higher refractive index to one of lower refractive index at an angle exceeding the critical angle. Here, the incident ray travels from water ($n \approx 1.33$) to glass ($n \approx 1.5$), so no total internal reflection occurs.

(ii) According to the new color convention, which color of wire is connected to:
(a) The metal body of the appliance?
(b) The switch of the appliance?

Sol :

(a) Green or Yellow
(b) Brown

(iii) (a) Which of the two, alternating current or direct current, produces a varying magnetic field when it flows through a conductor?
(b) State the frequency of the alternating current supply in India.

Sol :

(a) Alternating current
(b) 50 Hz

(iv) Calculate the amount of heat absorbed by 200 g of paraffin wax to melt completely at its melting point.
[Specific latent heat of fusion of paraffin wax $= 146\ \text{Jg}^{-1}$]

Sol :

As we know that,

$$L = \frac{Q}{m}$$

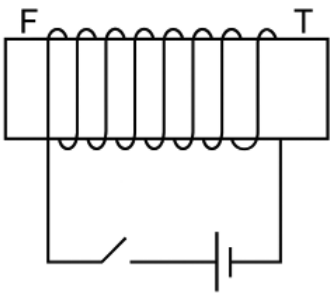
$$Q = L \times m$$

$$= 146 \times 20$$

$$= 29200\ \text{J}$$

$$= 29.2\ \text{KJ}$$

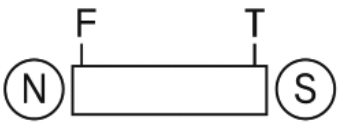
(v) Copper wire is wound a steel bar FT. Current is allowed to pass through the coil for some time and then the bar is removed.



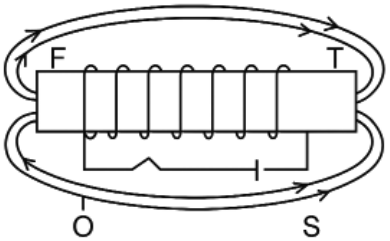
(a) Draw only the magnetic bar FT and mark its poles.
(b) Trace two magnetic lines of force around FT, clearly indicating the direction.

Sol :

(a)



(b)

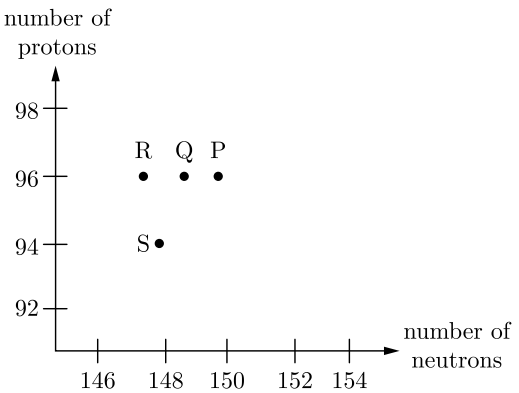


(vi) A current flows through a metallic conductor for a long period of time. State the change you would expect in its:
(a) Resistance
(b) Resistivity

Sol :

(a) Increases
(b) Increases

(vii) Curium is a radioactive element with the symbol $^{247}_{96}\text{Cm}$ named in honour of Madam Curie. The graph of number of protons vs number of neutrons for some elements are shown below:



Click Here to Buy book on Amazon

(a) Which point on the graph indicates the element Cm?
(b) Which point on the graph indicates the daughter nucleus after Cm undergoes radioactive decay of 1α followed by $2\beta^-$?
(c) State the mass number of the daughter nucleus.

Sol :

(a) *P*
(b) *R*
(c) $^{247}_{96}\text{Cm} \xrightarrow{\alpha-\text{decay}} {}^{243}_{94}\text{Cm} + {}^{4}_{2}\text{He}$

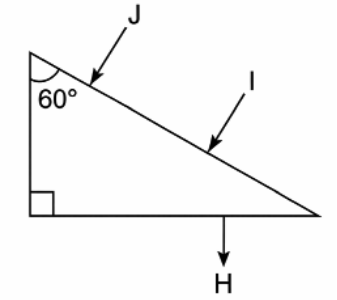
$^{243}_{94}\text{Cm} \xrightarrow{\beta-\text{decay}} {}^{243}_{95}\text{Cm} + {}^{0}_{-1}\text{e}$

$^{243}_{95}\text{Cm} \xrightarrow{\beta-\text{decay}} {}^{243}_{96}\text{Cm} + {}^{0}_{-1}\text{e}$

SECTION-B

QUESTION 4.

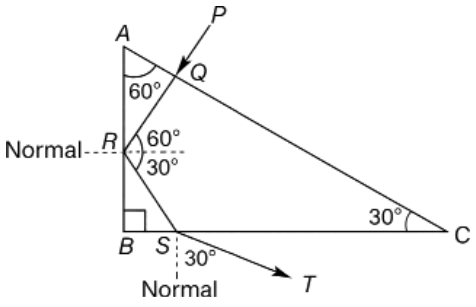
(i)



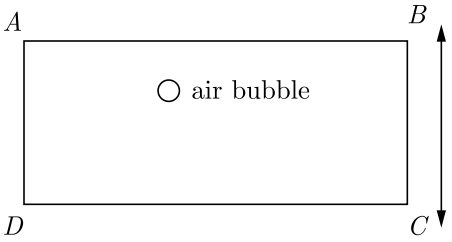
(a) Out of the three rays (I, J, H) shown in the diagram, which ray will suffer Total Internal Reflection while inside the prism?(Critical angle of the prism is 42°)
(b) Copy the diagram to complete the path of the ray which you have named in (a) till it comes out of the prism.

Sol :

(a) Ray J
(b)



(ii) A rectangular glass block of refractive index 1.5 has an air bubble trapped inside it.



(a) Calculate the actual depth of the air bubble from the surface AB if the apparent depth is 4 cm.
(b) For which color of light, blue or yellow, will the apparent depth be greater?
(c) Turning the glass block upside down does not change the apparent depth of the air bubble. True or False?

Sol :

(a) $\text{Real Depth} = \text{Apparent Depth} \times \text{Refractive Index}$

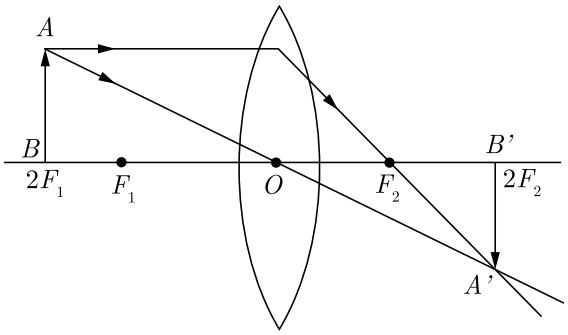
$= 4 \times 1.5 = 6\text{cm}$

(b) Yellow light
(c) False

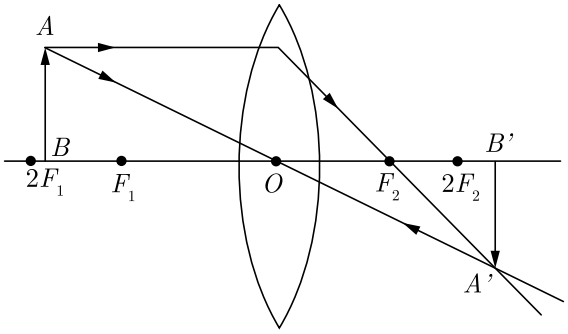
(iii) (a) An object is placed at 2F position of a convex lens. Draw a ray diagram showing the formation of the image.
(b) How will the size of the image change if we only replace the lens with another lens of a greater focal length?

Sol :

(a)



(b) Assuming that the object distance remains constant



NODIA

The size of the image will increase as shown in figure.

QUESTION 5.

(i) An object is placed in front of a concave lens at a distance of 45 cm from it. If its image is formed at a distance of 30 cm from the lens, calculate the focal length of the lens.

Sol :

Using the lens formula:

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

Given:

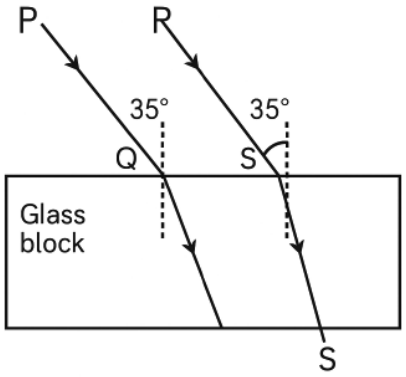
$$u = -45\text{cm} \quad v = -30\text{cm}$$

$$\frac{1}{f} = \frac{1}{-30} - \frac{1}{-45}$$

$$\frac{1}{f} = \frac{-3+2}{90} = \frac{-1}{90}$$

$$f = -90\text{cm}$$

(ii) Two rays PQ and RS are incident on a rectangular glass block as shown in the diagram. Observe the diagram and answer the questions that follow.



(a) Which of the two rays will have greater lateral displacement on emerging out of the block?
(b) Which of the two rays will travel with greater speed in the block?
(c) Which of the two rays will scatter more in the atmosphere?

Sol :

(a) RS
(b) PQ
(c) RS

(iii) (a) Name the radiations:
1. Which are used when a quartz prism is used to study the spectrum?
2. Which are used in remote sensing devices?
3. Which are used in traffic signals in India?

(b) Name one property common to all electromagnetic radiations.

Sol :

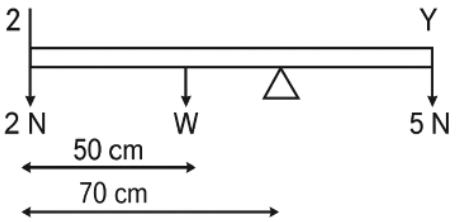
(a) 1. Ultraviolet radiations
2. Infrared radiations
3. Infrared radiations

(b) They can travel through vacuum.

QUESTION 6.

(i) Akash takes a uniform meter scale and suspends a weight of 2 N at one end "X" and a weight of 5 N on the other end "Y". He then balances the ruler horizontally on a knife edge placed at 70 cm from X. Draw a diagram of the arrangement and calculate the weight of the ruler.

Sol :



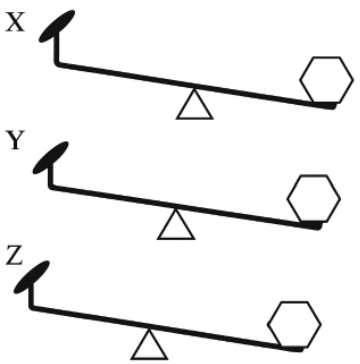
Because the ruler is balanced, the net torque acting on it must be zero.

$$2 \times 70 + W \times (70 - 50) - 5 \times 30 = 0$$

$$W \times 20 = 150 - 140$$

$$W = 0.5\text{N}$$

(ii) Three levers X, Y, Z of equal lengths are shown in the diagram.



(a) Which class of lever do these belong to?
(b) Among these (X, Y, or Z) which one will give the maximum mechanical advantage? Justify your answer.

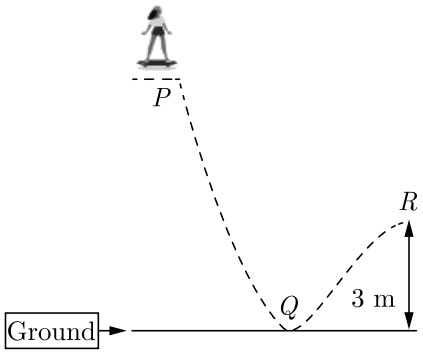
Sol :

(a) Class I lever
(b) Lever X
Justification:

Downloaded from www.pdf.tube

1. Maximum mechanical advantage is obtained when the effort arm is longer compared to the load arm.
2. In Lever X, the ratio of effort arm to load arm is the highest.

(iii)



Richa weighing 40 kgf leaves point P on her skateboard and reaches point Q on the ground with velocity 10 ms^{-1} . Calculate:

(a) The kinetic energy of Richa at point Q.
(b) The vertical height of point P above the ground.
(c) The kinetic energy of Richa at point R. (While moving from Q to R, she loses 500 J of energy against friction.)

Sol :

(a) As we know that,

$$KE = \frac{1}{2}mv^2$$

Here, m = 40 kgf

v = 10 m/s

$$= \frac{1}{2} \times 40 \times (10)^2$$

= 2000 J = 2 kJ

(b) Using Potential Energy formula:

v = mgh = 2 kJ

$$h = \frac{2000}{40 \times 10}$$

$$= 5\text{m}$$

(c) $KE_Q + PE_Q = KE_R + PE_R +$ loss in energy against friction

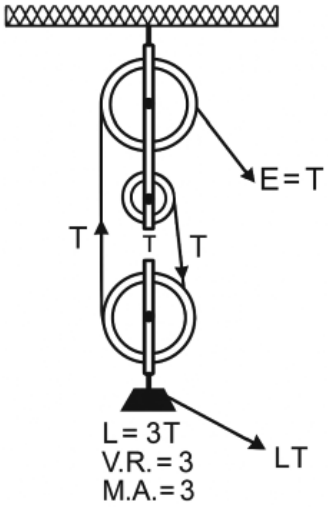
$$2000 + 40 \times 10 \times 30 = KE_R + 50$$

KE_R = 300 J

QUESTION 7.

(i) Draw a block and tackle system of pulleys with velocity ratio equal to 3.

Sol :



(ii) A submarine in the sea sends an ultrasonic ping and a stopwatch is started simultaneously. The stopwatch stops on receiving the reflected wave from an obstacle and reads 1 minute 40 seconds. Calculate the distance of the obstacle from the submarine.

Sol :

Using the formula:

$$v = \frac{2d}{t}$$

Given:

Time (t) = 1 minute 40 seconds = 100 s

Speed (v) = 1500 m/s

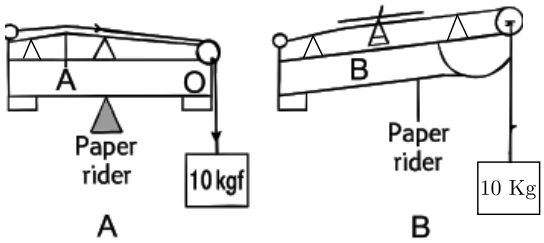
$$1500 = \frac{2d}{100}$$

$$d = \frac{1500 \times 100}{2}$$

$$= 75000\text{m} = 75\text{km}$$

Distance of the obstacle from the submarine 75 km.

(iii) The diagrams below show two sound boxes A and B with wires of the same length (l) and tension (10 kgf) but different cross-sectional areas. Simultaneously, vibrating tuning forks of frequency 300 Hz are placed on the boxes A and B. The paper rider falls off in case of B but not in case of A.



NODIA

(a) Name and explain the phenomenon responsible for the falling off of the paper rider in B.

(b) The wire A resonates with a tuning fork of frequency 'F'. Is 'F' greater than, less than, or equal to 300 Hz? Justify your answer.

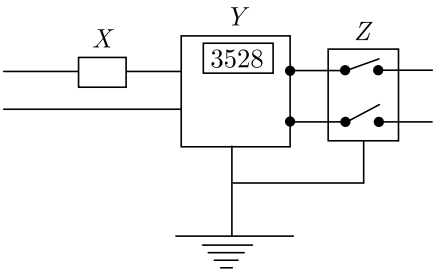
Sol :

(a) Resonance The paper rider in B falls off due to resonance. When the wire's natural frequency matches the tuning fork's frequency, the wire vibrates with increased amplitude, causing the paper rider to fly off.

(b) Less than 300 Hz. The frequency of a vibrating wire depends on its thickness. Since wire A is thicker than wire B, it has a lower natural frequency than 300 Hz. Therefore, F < 300 Hz.

QUESTION 8.

(i) The diagram shows wiring in a meter room of a building.



(a) What is the current rating of device X?

(b) What is the difference between switch Z shown in the diagram and the switches you use to operate different appliances at home?

(c) What is the unit of the physical quantity displayed in Y?

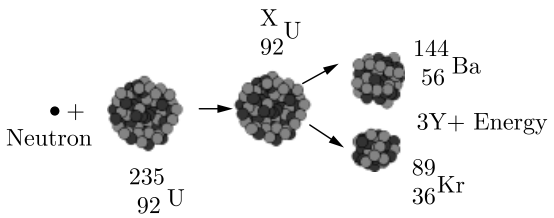
Sol :

(a) 30 A

(b) Switch Z is a double pole switch, which disconnects both the live and neutral wires simultaneously. Household switches are single pole switches, which disconnect only the live wire.

(c) kWh (kilowatt-hour)

(ii) Study the nuclear reaction diagram and answer the questions:



(a) Name the process depicted in the diagram.

(b) What is the value of X?

(c) Identify Y, the missing product of the reaction.

Sol :

(a) Nuclear fission of $^{235}_{92}U$ nucleus

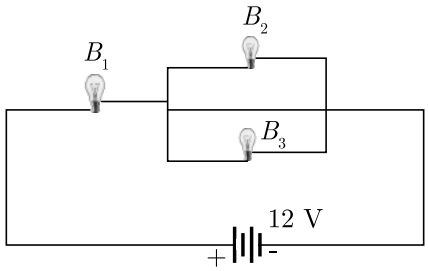
(b) Using conservation of mass number:

$$235 + 1 = X$$

$$X = 236$$

(c) Neutron $^{1}_{0}n$

(iii) Three identical bulbs B_1, B_2, B_3 (each of 18 W, 12 V) are connected to a 12 V battery.



(a) Calculate:

1. The resistance of each bulb.
2. The current drawn from the cell.

(b) If bulb B_3 is removed, will the brightness of B_1 increase, decrease, or remain the same?

Sol :

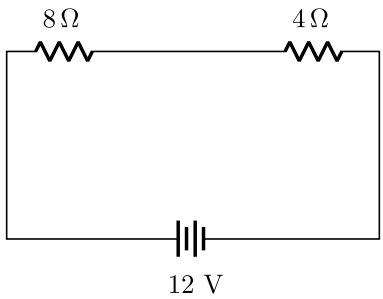
(a) 1. Using the formula:

$$R = \frac{V^2}{P}$$

$$R = \frac{(12)^2}{18}$$

$$R = 8\Omega$$

2. Total Resistance:



$$R_{net} = 8\Omega + 4\Omega = 12\Omega$$

$$I = \frac{V}{R} = \frac{12}{12} = 1A$$

(b) Brightness of B_1 will decrease

Reason: The effective resistance of the circuit increases, causing a decrease in current through B_1 .

Click Here to Buy book on Amazon

QUESTION 9.

(i) 30 g of ice at 0°C is used to bring down the temperature of a certain mass of water at 70°C to 20°C. Find the mass of water.
(Specific heat capacity of water = 4.2 $Jg^{-1}{}^{\circ}C^{-1}$ and specific latent heat of ice = 336 Jg^{-1})

Sol :

Heat energy take by ice = Heat energy given by water.
Using the heat balance equation:

$$m_i L_i + m_i s_w \Delta T = m_w s_w \Delta T$$

Substituting the values :

$$30 \times 336 + 30 \times 4.2 \times (20 - 0) = m_w \times 4.2 \times (70\text{-}20)$$

$$10080 + 2520 = m_w \times 4.2 \times 50$$

$$12600 = m_w \times 210$$

$$m_w = \frac{12600}{210} \text{ 60 g}$$

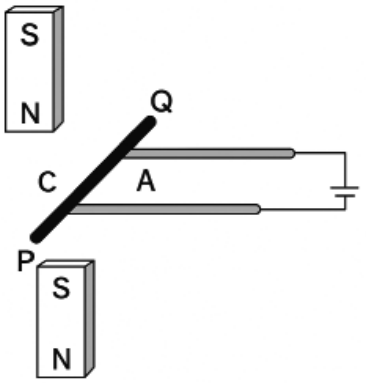
Thus, the mass of water m_w is 60 g.

(ii) (a) A certain amount of heat will warm 1 g of material X by 10°C and 1 g of material Y by 40°C. Which material has higher specific heat capacity?
(b) Which material, X or Y, would you select to make a calorimeter?
(c) The specific heat capacity of a substance remains the same when it changes its state from solid to liquid. True or False?

Sol :

(a) Material X
Since $C \propto \frac{1}{\Delta T}$, material Y heats up more, meaning X has a higher specific heat capacity.
(b) Material Y A calorimeter should not absorb much heat, so it should have a low specific heat capacity.
(c) False

(iii) A copper rod PQ carrying current is kept in a magnetic field as shown in the diagram.



(a) The copper rod PQ will move towards C. State True or False.
(b) Name the law used to determine the direction of motion of PQ.
(c) What will be the effect on the force experienced if the rod PQ is replaced by another copper rod of the same length but greater cross-sectional area?
(d) Justify your answer in (c).

Sol :

(a) True
(b) Fleming's Left-Hand Rule
(c) The force will remain the same.
(d) Force is given by:

$$F = BIL \sin \theta$$

Force is independent of cross-sectional area of the rod.

www.nodia.in

Downloaded from www.pdf.tube

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!

CHAPTER 1

FORCE TURNING FORCES AND UNIFORM CIRCULAR MOTION

SUMMARY

1. FORCE

Force is an external effort in the form of push or pull which changes/tends to change the state of rest or of uniform motion of an object along a straight line or changes/tends to change the shape of the object.

The SI unit of force is Newton (N). 1 Newton is that force which produces an acceleration of 1 ms^{-2} in an object of mass 1 kg. The CGS unit of force is dyne. 1 dyne is that force which produces an acceleration of 1 cm^2 in an object of mass 1 g.

$$1\,\text{N} = 10^5 \text{ dyne}$$

The gravitational units of force are kilogram force (or kilogram weight) and gram force (or gram weight) which are symbolically represented as $1\,\text{kg}-f$ (or $\text{kg}-\text{wt}$) and $g-f$ or $(g-wt)$ respectively.

$$1\,\text{kg}-f \text{ (or kg}-wt) = 9.8\,\text{N}$$

$$1\,\text{g}-f \text{ (or } g\,wt) = 980 \text{ dyne}$$

In the mathematical form its is defined as the rate of change of linear momentum

$$\text{Force, } F \propto \frac{\text{Change in momentum}}{\text{time}}$$

$$\propto \frac{p_1 - p_2}{t}$$

$$\propto \frac{m(v-u)}{t} \Rightarrow F \propto ma$$

$$F = kma$$

Where, k=1

$$F = ma$$

2. MASS AND WEIGHT

The mass of an object is defined as the quantity of matter contained in the object. It is a scalar quantity. Its SI unit is kilogram (kg).

The weight of an object on the earth is the gravitational pull exerted on it by the earth. Weight is a vector quantity. It is expressed as

$$w = mg$$

where, m is the mass of the object and g, is the acceleration due to gravity.

As g varies from place to place on the earth, the weight of an object of mass m also varies. Its SI unit is the unit of force, i.e., Newton.

3. RIGID BODY

Every material object is made up of a large number of particles. A rigid body is one whose size and shape remain the same whatever force be applied to different parts of it. In an actual practice, no material object is truly rigid.

4. MOTION OF RIGID BODY

A rigid object has two types of motion, viz. translatory motion and rotatory motion.

4.1 Translational Motion

In a translational motion, on application of a force, an object starts moving bodily with all its particles moving along parallel lines in the direction of force with the same speed.

4.2 Rotational Motion

In a rotatory motion, when a force is applied on an object at a fixed point, an object starts rotating about that point with its particles moving along concentric circles with different speeds.

Rotational effect of a force depends on two factors, viz.

(i) the magnitude of the force (F), and

(ii) perpendicular distance of its line of action from the axis or point about which rotation is taking place.

5. SOME DEFINITIONS RELATED TO FORCE

Some definition regarding to the force is given below :

(i) Point of action of force is that point on a rigid object where a force acts.

(ii) Line of action of force is an imaginary line

NODIA

passing through point of action of force drawn in the direction of force.

(iii) According to the principle of transmissibility, the effect of a force on a rigid object depends upon its magnitude and on the line along which it acts and remains unaltered if the point of application is shifted to some other point on the same line of action.

6. MOMENT OF FORCE OR TORQUE

The turning effect of a force acting on an object about an axis is called moment of force or torque. Mathematically, moment of force or the torque exerted by the force about the point is the product of the applied force (F) and the perpendicular distance of its line of action from the point about which the object is free to rotate.

Moment of force or torque produced by a force about an axis is equal to the product of the magnitude of force and its lever arm about the axis. It is represented by τ (tau).

$$\text{Torque } (\tau) = \text{ Force } (F) \times \text{ Lever arm } (d_{\perp})$$

Moment of force or torque is a vector quantity. Its SI unit is newton-metre (N-m) and CGS unit is dyne-centimetre (dyne-cm).

$$1\,\text{N} - \text{m} = 10^7\,\text{dyne} - \text{cm}$$

Moment of force is assigned a positive sign if the turning tendency of the force is anticlockwise and a negative sign if the turning tendency of the force is clockwise.

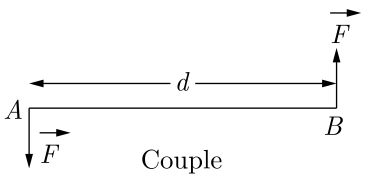
7. COUPLE

Couple is a pair of equal and opposite forces whose lines of action of forces are not the same. Couple causes the object to execute rotational motion.

Arm of the couple is the perpendicular distance between two equal and unlike parallel forces.

8. MOMENT OF A COUPLE

The moment of a couple is equal to the product of either of the forces and the perpendicular distance (called the arm of the couple) between their lines of action, *i.e.*,



Moment of a couple = either force $\times$ perpendicular distance between the forces

$$= \text{force} \times \text{couple arm}$$

$$= F \times d$$

The SI unit of moment of couple is newton-metre denoted by $\text{N} - \text{m}$. Its CGS unit is dyne-cm.

9. PRINCIPLE OF MOMENTS

According to the principle of moments, the sum of anticlockwise moments of forces about any point must be equal to the sum of clockwise moments of the forces about the same point.

10. EQUILIBRIUM OF AN OBJECT

An object is said to be in equilibrium if a number of forces acting on it produce no change in its state of rest or of uniform motion (translational or rotational).

1. An object in equilibrium is not necessarily in rest while an object at rest is necessarily in equilibrium.
2. An object is said to be in static equilibrium if it remains in the state of rest under the influence of applied forces.
3. An object is said to be in dynamic equilibrium if it remains in the state of uniform motion (translational or rotational).

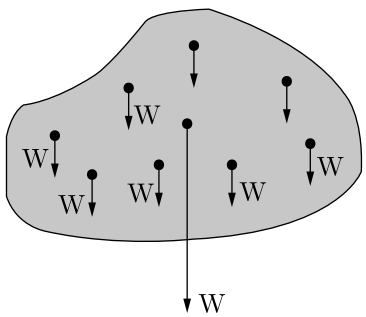
Under the action of a set of parallel forces, the two conditions for an object to be in equilibrium are:

(i) The resultant of all the forces acting on an object must be equal to zero.

(ii) The resultant moment of all the forces acting on the object about a point should be zero *i.e.*the sum of the anticlockwise moments about any point must be equal to the sum of the clockwise moments about the same point.

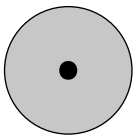
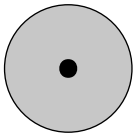
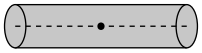
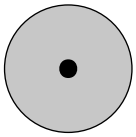
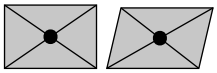
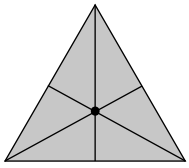
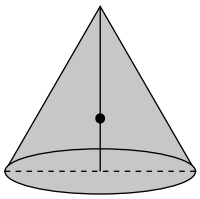
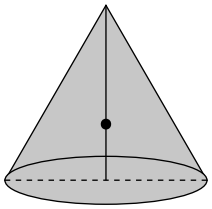
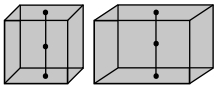
11. CENTRE OF GRAVITY

Centre of gravity of an object is a point at which its total weight may be supposed to act.



Click Here to Buy book on Amazon

The position of the centre of gravity of some regular shaped objects having uniform density is given in the following table:

Object	Figure of the object	Centre of gravity
Uniform rod		Mid-point of rod
Circular disc		Geometric centre
Sphere (solid or hollow)		Geometric centre of the sphere
Cylinder		Mid-point on the axis of the cylinder
Circular ring		Centre of the ring
Rectangle or parallelogram		The point of intersection of the diagonals
Triangular lamina		The point of intersection of medians
Hollow cone		At a height $(h/3)$ from the base on its axis
Solid cone		At a height $(h/4)$ from the base on its axis
Cube/Cuboid		At the point of intersection of diagonals

12. STABLE EQUILIBRIUM

An object is said to be in stable equilibrium if it has a tendency to return to its original equilibrium position after being slightly disturbed e.g., *a* cone lying on its base.

Conditions for an object in stable equilibrium are:

(i) The centre of gravity of the object must be as low as possible.

(ii) The vertical imaginary line from the centre of gravity must pass through the base or area of the support of the object.

13. UNSTABLE EQUILIBRIUM

An object is said to be in unstable equilibrium if it does not regain its original equilibrium position after being slightly disturbed.

Conditions for an object to be in unstable equilibrium are:

(i) The centre of gravity must be at its highest position, and

(ii) On tilting the object slightly, the centre of gravity is lowered but when left the centre of gravity tends to lower itself further and hence the object topples.

NODIA

14. NEUTRAL EQUILIBRIUM

An object is said to be in neutral equilibrium, if after being slightly disturbed, the body does not have any tendency either to regain its original equilibrium position or to tilt further from its new position.

Conditions for an object to be in neutral equilibrium are:

(i) The centre of gravity should remain unaffected on tilting the body, *i.e.* neither lowered nor raised.

(ii) The vertical line joining the centre of gravity and centre of the earth must always fall within the base of the object.

15. UNIFORM CIRCULAR MOTION

If an object moves on a circular path with a constant speed, its motion is said to be a uniform circular motion in a plane. In uniform circular motion, the speed of the body remains constant but direction changes continuously, due to which velocity changes continuously, *i.e.* there is an acceleration in the uniform circular motion which is always directed towards the centre of the circle. It is called centripetal acceleration.

15.1 Centripetal Force

If a body performing uniform circular motion, it

is acted upon by a force which is directed towards the centre of the circle is called centripetal force. Centripetal force is not a new force. Frictional force, gravitational force, electrical and magnetic force may act as a centripetal force.

15.2 Centrifugal Force (a pseudo force)

Centrifugal force (a pseudo force) is an apparent force in a certain situation that a object appears to be acted upon by a force while there is no force acting on the object.

MULTIPLE CHOICE QUESTION

1. A moment of couple has a tendency to rotate the body in an anticlockwise direction. Then the moment of couple is taken as:
(a) positive (b) negative
(c) maximum (d) zero

Ans : SQP 2025

If couple has a tendency to rotate the body in anti-clockwise direction then its moment is taken positive and if the tendency of rotation is clockwise then the moment is negative.
Thus (a) is correct option.

2. Which of the following is a class III lever?
(a) Pair of scissors (b) Wheelbarrow
(c) Crowbar (d) Human forearm

Ans : MAIN 2024

For class III lever force is applied in between the fulcrum and the load.
In human forearm, elbow is the pivot, bicep muscle applies the force and load is placed on the palm. Hence, it is a class III lever.
Thus (d) is correct option.

3. A door lock is opened by turning the lever (handle) of length 0.2 m. If the moment of force produced is 1 Nm, then the minimum force required is
(a) 5 N (b) 10 N
(c) 20 N (d) 0.2 N

Ans : MAIN 2024

Moment of Force = 1 N-m
Length of handle = 0.2 m
Moment of a force = Force × perpendicular distance from the line of action of the force

$$1 = F \times 0.2$$

$$F = 5 \text{ N}$$

Thus (a) is correct option.

4. The condition for equilibrium is :
(a) The resultant of moments of all the forces acting on the body about the turning point should be zero.
(b) The resultant of all the forces acting on the body be zero only.
(c) Both (a) and (b)
(d) None of the above

Ans : COMP 2024

An object is in equilibrium in a reference coordinate system when all external forces (including moments) acting on it are balanced. This means that the net result of all the external forces and moments acting on this object is zero.
Thus (a) is correct option.

5. A moment of couple has a tendency to rotate the body in an anticlockwise direction. Then the moment of couple is taken as:
(a) positive (b) negative
(c) maximum (d) zero

Ans : SQP 2024

When the body tends to rotate in the anticlockwise direction under the influence of a Couple, then its moment is called positive moment.
Thus (a) is correct option.

6. Calculate the force which will produce a moment of force of 1575 dyne-cm, when the perpendicular distance between point of application of force and turning point is 45 cm.
(a) 75 dyne (b) 45 dyne
(c) 35 dyne (d) 25 dyne

Ans : SQP 2024

$$F = ?$$

Moment of force = 1575 dyne-cm

Perpendicular distance = 45 cm

$$F = \frac{\text{moment of force}}{\text{Perpendicular distance}}$$

$$F = \frac{1575}{45}$$

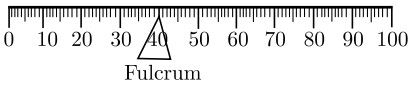
$$= 35 \text{ dyne}$$

Thus (c) is correct option.

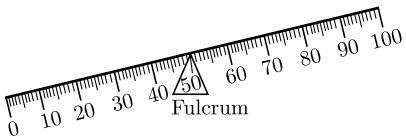
FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

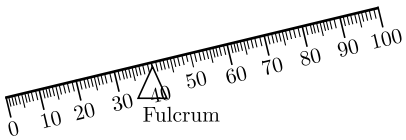
Downloaded from www.pdf.tube

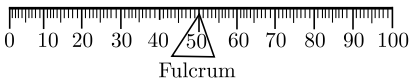
7. The diagram below shows the balanced position of a meter scale.

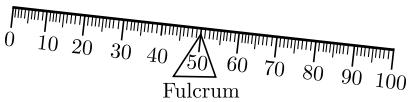


Which one of the following diagrams shows the correct position of the scale, when it is supported at the centre?

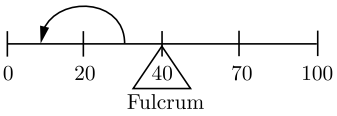
(a) 

(b) 

(c) 

(d) 

Ans : MAIN 2021 SEM - 1



Let us suppose left side have mass m and right side have mass m'.
Consider centre of mass at 20 cm and at 70 cm for left and right side respectively.
By moment of force,

$$mg \times 20 = m'g \times (30)$$

$$m = \frac{3}{2}m'$$

Here, left hand side is more heavy, so it will bend or rotate more towards left side as compared to right side when fulcrum is placed at 50 cm mark.
Thus (a) is correct option.

8. The weight of an object lies at the .....
(a) Geometric centre always
(b) Centre of gravity
(c) Centre of buoyancy
(d) Centre of mass

Ans : COMP 2000

The centre of gravity is an imaginary point at which the entire weight of a body may be considered as concentrated.
Thus (b) is correct option.

9. Moment of force is given by
(a) force × parallel distance between axis of rotation.
(b) force × perpendicular distance.
(c) Torque × perpendicular distance.
(d) None of these

Ans : SQP 2018

Moment of force = force × perpendicular distance
Thus (b) is correct option.

10. When a body moves in a circular path, outward force is called a .....
(a) Centripetal force (b) Reaction force
(c) Centrifugal force (d) Pseudo force

Ans : MAIN 2015

Centripetal force is the component of force acting on an object in curvilinear motion which is directed towards the axis of rotation or centre of curvature. Centrifugal force is a pseudo force in a circular motion which acts along the radius and is directed away from the centre of the circle.
Thus (c) is correct option.

11. Clockwise moments are considered to be .....
(a) zero (b) positive
(c) negative (d) all of these

Ans : COMP 2012

As a matter of convention, an anticlockwise moment is taken as positive and a clockwise moment is taken as negative.
Thus (c) is correct option.

12. A body is acted upon by two unequal and opposite forces along different lines of action of force. The body will have
(a) only rectilinear motion
(b) only rotatory motion
(c) only translatory motion
(d) both (a) and (b)

Ans : SQP 2010

Since the forces are unequal, net force will be non-zero and will result in translation motion. Also, since they are acting on two sides of the pivot point, they develop moments in the same direction and the net moment will be non-zero. Thus, it results in rotational motion also.
Thus (b) is correct option.

NODIA

13. As a body moves in a circular path, inward seeking force is called .....
(a) Centripetal force (b) Centrifugal force
(c) Tension force (d) Tangential force

Ans : MAIN 2009

A centripetal force is a net force that acts on an object to keep it moving along a circular path.
Thus (a) is correct option.

14. Centre of gravity of a solid and hollow sphere are .....
(a) almost the same
(b) the same
(c) different
(d) Geometric centre

Ans : COMP 2008

Due to their weights there would be a small difference in relative position of center of gravity.
Thus (a) is correct option.

15. The point of action of force on a rigid body is :
(a) Fixed point, but can be transferred anywhere opposite to the direction of force.
(b) Fixed point on rigid body
(c) Fixed point but can be transferred any where along the line of action of force.
(d) Fixed point but can be transferred anywhere along the direction of force.

Ans : MAIN 2020

The point of action of force on a rigid body is a fixed point but can be transferred anywhere along the line of action of force.
Thus (a) is correct option.

16. The turning effect produced in a rigid body around a fixed point by the application of force is called
(a) movement of force
(b) moment of couple
(c) turning force
(d) none of these

Ans : COMP 2013

The turning effect of force is called Torque
Thus (a) is correct option.

17. A body is describing a uniform circular motion. Which of the following quantities is/are constant
(a) velocity (b) speed
(c) acceleration (d) both (a) and (b)

Ans : SQP 2020

The speed and the angular velocity remain constant in case of uniform circular motion.
Thus (b) is correct option.

18. The centre of gravity of a cricket ball is at :
(a) at any point on its surface
(b) at its bottom touching the ground
(c) its geometric centre
(d) its top most point

Ans : MAIN 2023

For a uniform ball, the centre of gravity lies at the point of intersection of any two of its diameters, which is at the geometrical centre of the ball.
Thus (c) is correct option.

19. Lesser the force applied ..... is the moment of force.
(a) lesser (b) equal
(c) greater (d) unit

Ans : COMP 2000

Moment of force is directly proportional to force
Thus (a) is correct option.

20. The moment of couple is mathematically the :
(a) product of one force and the perpendicular distance between the point of application of force and turning point.
(b) product of both forces and the perpendicular distance between them.
(c) product of one force and the perpendicular distance between two forces.
(d) None of the above.

Ans : SQP 2014

Moment of couple = force $\times$ couple arm.
Thus (b) is correct option.

21. A force F acts on a rigid body capable of turning around a fixed point. The moment of force depends upon
(a) magnitude of perpendicular distance between the point of action of force and the turning point
(b) magnitude of force F
(c) both (a) and (b)
(d) none of these

Ans : COMP 2012

Moment of force about the point is the product of force and the perpendicular distance between the axis of rotation and line of action of force.
Hence, it depends on both of them.
Thus (c) is correct option.

Click Here to Buy book on Amazon

22. In a uniform circular motion :
(a) the motion of body is accelerated
(b) speed of body continuously changes because the direction of motion changes
(c) velocity of body continuously changes because the direction of motion changes
(d) both (b) and (c)

Ans : COMP 2017

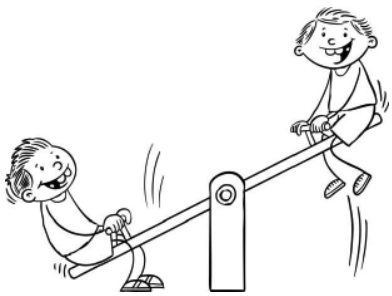
In a uniform circular motion, the speed is constant but the direction of motion is continuously changing due to which velocity continuously changes. Therefore, uniform circular motion is also called as accelerated motion.
Thus (d) is correct option.

23. ..... moments are considered to be positive.
(a) Total (b) Clockwise
(c) Anticlockwise (d) None of these

Ans : MAIN 2010

Since moments are vectors hence are associated with directions too.
Thus (c) is correct option.

24. Manoj of mass 55 kg and Ashok of mass 40 kg are sitting on a see saw at a distance of 2 m and 1.5 m respectively from the centre of the see saw in an amusement park as shown in the figure. Is the see saw in rotational equilibrium?



(a) data incomplete (b) Yes
(c) No (d) None of the above

Ans : COMP 2022

According to the principle of moments the see saw in rotational equilibrium
Thus (c) is correct option.

25. The unit of moment of force in SI system is :
(a) N-cm (b) dyne-m
(c) dyne-cm (d) N-m

Ans : MAIN 2014

Moment of force is defined as the product of force and perpendicular distance from the axis; so its SI unit is Newton-meter (Nm).
Thus (d) is correct option.

26. The weight of a uniform half meter scale would act at ..... mark.
(a) 50 cm (b) 25 cm
(c) 100 cm (d) 0 cm

Ans : SQP 2004

Centre of gravity would be the midpoint of 50 cm.
Thus (b) is correct option.

27. The centre of gravity of a regular object will depend on .....
(a) Density of the body
(b) Volume of the body
(c) distribution of mass
(d) All of these

Ans : COMP 2017

Centre of gravity of given mass depend on its shape and on the distribution of mass.
Thus (c) is correct option.

28. Uniform linear motion has .....
(a) Variable speed, variable velocity
(b) Constant speed, constant velocity
(c) Constant speed, variable velocity
(d) Variable speed, constant velocity

Ans : SQP 2009

Same speed and same direction as it is linear motion.
Thus (b) is correct option.

29. The centre of gravity of a regular object would lie .....
(a) outside the body
(b) inside the body
(c) on the body
(d) all of these

Ans : MAIN 2006

2D objects on the body while 3D objects outside as well as inside the body.
Thus (d) is correct option.

30. Huge trailer trucks have their steering wheel of ..... diameter.
(a) least (b) large
(c) small (d) all of these

Ans : SQP 2018

Larger couple arm large is moment of couple.
Thus (b) is correct option.

NODIA

31. Centre of gravity is ..... when it is a hollow cone.
(a) centre of vertical axis
(b) raised from the base
(c) lower towards the base
(d) none of these

Ans : MAIN 2016

Lighter the object the more is the height of CG from the base.
Thus (b) is correct option.

32. For equilibrium, ... sum of all moments is equal to ..... sum of all anticlockwise moments.
(a) Arithmetic, arithmetic
(b) Algebraic, algebraic
(c) Total, none of
(d) All of these

Ans : SQP 2000

Since moments are vectors hence are associated with directions too.
Thus (a) is correct option.

33. A force of 50 N produces a moment of force of 10 Nm in a rigid body. Calculate the perpendicular distance between the point of application of force and the turning point is 45 cm.
(a) 1.5 m (b) 0.1 m
(c) 0.2 m (d) 0.8 m

Ans : COMP 2000

$$\text{Force } F = 50 \text{ N}$$

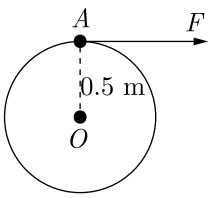
$$\text{Moment of force} = 10 \text{ Nm}$$

$$\text{Moment of force} = F \times \text{Perpendicular distance}$$

$$\text{Hence, Perpendicular distance} = \frac{10}{50} = 0.2 \text{ m}$$

Thus (c) is correct option.

34. The diagram alongside shows a force F acting at point A, such that it produces a moment of force of 20 Nm in clockwise direction. Calculate the magnitude of force F.

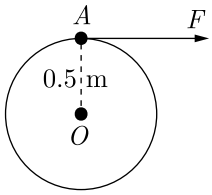


(a) 30 N (b) 40 N
(c) 10 N (d) 20 N

Ans : SQP 2011

$$\text{Moment of force} = F \times OA$$

$$2 = F \times 0.5$$



$$F = \frac{20}{0.5} = 40 \text{ N}$$

Thus (b) is correct option.

NODIA

35. The relation between CGS and SI unit of moment of force is
(a) 1 Nm = 10^5 dyne cm
(b) 1 Nm = 10^5 dyne
(c) 1 Nm = 10^7 dyne cm
(d) 1 dyne-cm = 10^7 Nm

Ans : SEM-I 2021

$$1 \text{ newton} = 10^5 \text{ dyne}$$

$$1 \text{ Nm} = 10^5 \times 10^2 \text{ dyne-cm}$$

$$1 \text{ Nm} = 10^7 \text{ dyne-cm}$$

Thus (c) is correct option.

36. Find the resultant moment of couple if two equal forces each of 6 N are acting at a distance of 3 cm each from the centre.
(a) 3.6 Nm (b) 0.36 Nm
(c) 360 Nm (d) 36 Nm

Ans : COMP 2019

Distance given is radius but diameter is couple arm so multiply by 2.
Couple arm = 3 × 2 = 6 cm = 0.06 m
Moment of couple is given by

$$= \text{force} \times \text{couple arm}$$

$$= 6 \times 0.06 = 0.36 \text{ Nm}$$

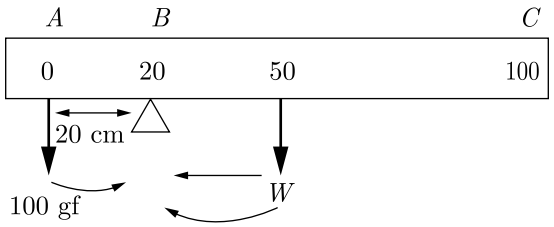
Thus (b) is correct option.

37. A uniform metre scale is balanced at 20 cm mark, when a weight of 100 gf is suspended from one end. Where must the weight be suspended ? Calculate the weight of the metre scale.
(a) 77.77 gf (b) 11.11 gf
(c) 88.88 gf (d) 66.66 gf

Ans : SQP 2008

Let W be the weight of metre scale. As the scale is

balanced at 20 cm and 100 gf is suspended on one end (0 mark). The weight of longer arm i.e. BC is balanced by 100 gf.



$$\text{Clockwise moment} = \text{Anti clockwise moment}$$

$$W \times 30 = 20 \times 100$$

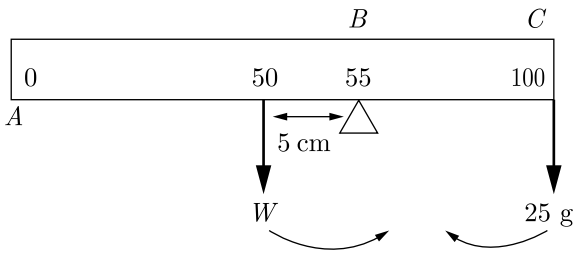
$$W = \frac{2000}{30}$$

$$= 66.66 \text{ gf}$$

Weight of 100 gf should be suspended at zero mark.
Thus (d) is correct option.

38. A uniform metre scale balances horizontally on a knife edge placed at 55 cm mark, when a mass of 25 g is supported from one end. Draw the diagram of the arrangement. Calculate mass of the scale.
(a) 400 g (b) 275 g
(c) 100 g (d) 225 g

Ans : MAIN 2010



As the metre scale is balanced at 55 cm mark i.e. large arm is balanced by arm BC and 25 g is suspended at one end i.e. at 100 cm mark
Hence, Anticlockwise moment = clockwise moment

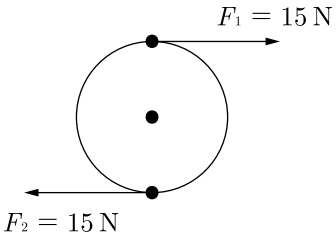
$$W \times (55 - 50) = 25 \times (100 - 55)$$

$$5W = 25 \times 45$$

$$W = \frac{25 \times 45}{5} = 225 \text{ g}$$

Thus (d) is correct option.

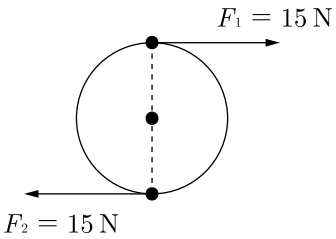
39. Two forces F_1 and F_2 are applied on a circular body such that moment of couple is 9 Nm in clockwise direction. Calculate the radius of circular body.



(a) 10 cm (b) 60 cm
(c) 30 cm (d) 40 cm

Ans : SQP 2000

Two forces $F_1 = F_2$ are parallel but in opposite direction constitute a couple



$$\text{Moment of couple} = F \times \perp \text{ distance } AB$$

$$9 \text{ Nm} = 15 \text{ N} \times 2r \text{ (radius)}$$

$$r = \frac{9}{30} = 0.30 \text{ m}$$

$$= 30 \text{ cm}$$

Thus (c) is correct option.

40. A force of 50 dyne acts on a rigid body, such that the perpendicular distance between the fulcrum and the point of application of force is 75 cm. Calculate the moment of force.
(a) 2500 dyne cm (b) 3750 dyne cm
(c) 3975 dyne cm (d) 1580 dyne cm

Ans : MAIN 2015

$$\text{Force } F = 50 \text{ dyne}$$

$$\text{Perpendicular distance} = 75 \text{ cm}$$

$$\text{Moment of force} = F \times \text{Perpendicular distance}$$

$$= 50 \times 75$$

$$= 3750 \text{ dyne cm}$$

Thus (b) is correct option.

41. Find the maximum force required to open a nut by a spanner of length 50 cm producing a torque of 50 Nm?
(a) 0.1 N (b) 10 N
(c) 100 N (d) None of these

Ans : COMP 2000

Downloaded from www.pdf.tube

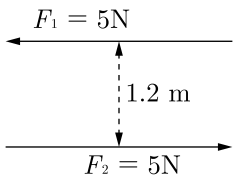
Moment of force = force × perpendicular distance

$$50 = \text{Force} \times \frac{50}{100}$$

$$\text{Force} = \frac{50 \times 100}{50} = 100 \text{ N}$$

Thus (c) is correct option.

42. Study the diagram given below and calculate the moment of couple.



(a) 2 Nm (b) 1 Nm
(c) 6 Nm (d) 4 Nm

Ans : COMP 2023

$F_1 = F_2 = F = 5$ N forces being equal opposite and parallel Couple arm = 1.2 m
Hence, the moment of couple

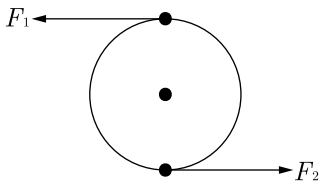
$$= F \times \text{Perpendicular distance}$$

$$= 5 \times 1.2$$

$$= 6 \text{ Nm}$$

Thus (c) is correct option.

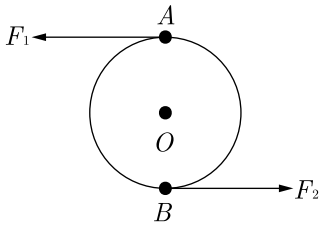
43. Two forces $F_1 = F_2$ are applied on a wheel of 1.5 m radius, such that moment of couple is 30 Nm. Calculate the magnitude of each of the force.



(a) 10 N (b) 60 N
(c) 20 N (d) 40 N

Ans : SQP 2017

Anticlockwise direction



$F_1 = F_2 = F$ in opp. direction and are parallel
Hence constitute a couple.

Moment of couple = $F \times$ diameter AB

$$30 = F \times (2 \times 1.5)$$

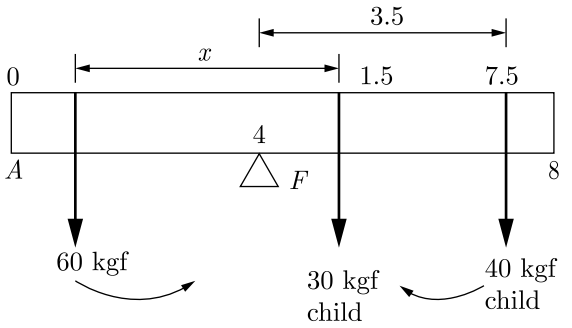
$$F = \frac{30}{3} = 10 \text{ N}$$

Thus (a) is correct option.

44. A see-saw 8 m long is balanced in the middle. Two children of mass 30 kgf and 40 kgf are sitting on the same side of the fulcrum at a distance of 1.5 m and 3.5 m from the fulcrum respectively. Where must a lady weighing 60 kgf sit from the fulcrum, so as to balance the see-saw ?

(a) 6.15 m (b) 4.15 m
(c) 3.08 m (d) 2.17 m

Ans : MAIN 2011



Let lady of 60 kgf sits at a distance from 4 metre mark
Hence, Anti-clock wise moment = clockwise moment

$$60 \times x = (30 \times 1.5) + (40 \times 3.5)$$

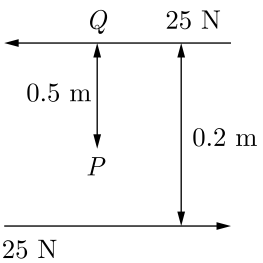
$$60x = 45 + 140 = 185$$

$$x = \frac{185}{60}$$

$$= \frac{18.5}{6} = 3.08 \text{ m}$$

Hence, Lady must sit on opposite side of children at 3.08 m from fulcrum F.
Thus (c) is correct option.

45. From the given figure, calculate moment of force about (i) P and (ii) Q.



(a) 10 N-m clockwise, 5 Nm anti-clockwise
(b) 5 N-m clockwise, 10 Nm anti-clockwise
(c) 10 N-m clockwise, 10 Nm anti-clockwise
(d) 5 N-m clockwise, 5 Nm clockwise

Ans : COMP 2015

From the given figure,

(i) At point P two torques τ_1 and τ_2 acting from distances 0.05 m and $(0.2 - 0.05 = 0.15)$ 0.15 m.
Hence,

$$\text{Torque, } \tau_1 = \text{force} \times \text{distance}$$
$$= 25 \times 0.05$$
$$= 1.25 \text{ N clockwise}$$
$$\text{Torque, } \tau_2 = 25 \times (0.2 - 0.05)$$
$$= 25 \times 0.15$$
$$= 3.75 \text{ N clockwise}$$

Hence, $\text{Total torque} = \tau_1 + \tau_2$
$$= 1.25 + 3.75$$
$$= 5 \text{ Nm, clockwise}$$

(ii) Now, at point Q two torques τ_1 and τ_2 will be
$$\tau_1 = F_1 \times 0 = 0$$
$$\tau_2 = 25 \times 0.2$$
$$= 25 \times \frac{2}{10}$$
$$= 5 \text{ N, clockwise}$$

Hence, $\text{net torque} = \tau_1 + \tau_2$
$$= 0 + 5 = 5 \text{ Nm, clockwise}$$

Thus (d) is correct option.

46. The length of seconds hand of a clock is 10 cm. The angular speed of the tip of the hand is

(a) $\frac{\pi}{300}\text{rad s}^{-1}$ (b) $\frac{\pi}{40}\text{rad s}^{-1}$

(c) $\frac{\pi}{3000}\text{rad s}^{-1}$ (d) $\frac{\pi}{30}\text{rad s}^{-1}$

Ans : MAIN 2000

Length of seconds hand of a clock = 10 cm.

Angular speed, $\omega = \frac{\theta}{t}$

But $\theta = 2\pi$, $t = 60$ s

$$\omega = \frac{2\pi}{60}$$
$$= \frac{\pi}{30}\text{rad s}^{-1}$$

Thus (d) is correct option.

47. When a car of mass M passes through a convex bridge of radius r with velocity v, then it exerts a force on it. What is the magnitude of the force ?

(a) $\frac{Mv^2}{r}$ (b) $Mg - \frac{Mv^2}{r}$

(c) $Mg + \frac{Mv^2}{r}$ (d) Mg

Ans : COMP 2017

When a car of mass M passes through a convex bridge of radius r with velocity v, it exerts a force on it, in following ways

(i) The weight mg of the car acting vertically downwards.
(ii) Normal reaction R of the road on the car, acting vertically upwards. As the radius of the bridge is r, hence the centripetal force is along the surface of the road, towards the centre of turn.

Hence, the magnitude of force $= Mg - \frac{Mv^2}{r}$.

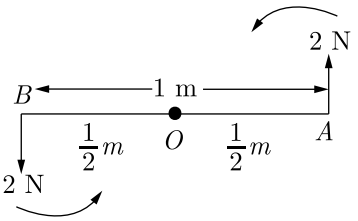
Thus (b) is correct option.

48. Two forces each of magnitude 2 N act vertically upward and downward respectively on two ends of a uniform rod of length 1m, freely pivoted at its centre. Determine the resultant moment of forces about the mid-point of the rod.

(a) 6 Nm (b) 2 Nm
(c) 4 Nm (d) 1 Nm

Ans : SQP 2006

As the two equal forces 2 N are acting at the ends of pivoted rod AB. These constitute a couple in anti-clockwise direction.



Moment of force at A about
$$O = 2 \times \frac{1}{2} = 1 \text{ Nm}$$

Moment of force at B about
$$O = 2 \times \frac{1}{2} = 1 \text{ Nm}$$

Hence, Resultant moment of force 1 + 1 = 2 Nm
Thus (b) is correct option.

FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

Click Here to Buy book on Amazon

49. A tap is used to fill bucket of water under a tap as shown in the figure. Name the force acting on the tap which produces rotational motion?

(a) Centripetal force (b) Tension force
(c) Centrifugal force (d) Couple

Ans : MAIN 2007

While opening a tap the system of forces acting are two equal opposite and parallel forces.
Thus (d) is correct option.

50. A mechanic can open a nut by applying 120 N force while using a lever of 50 cm length. How long should the handle be, if he wishes to open, it by applying a force of only 40 N ?
(a) 1.5 m (b) 1 m
(c) 2.5 m (d) 2 m

Ans : COMP 2010

A nut cracker is an example of second class of lever, where fulcrum is one side and load (nut) is between fulcrum and effort.
According to the question,

$$\text{Moment of force} = F \times d$$

$$= 120 \times \frac{50}{100} = 60 \text{ Nm}$$

As the same moment of force acts on the nutcracker by applying a force of 40 N, then applying formula.

$$\text{Moment of force} = F \times d$$

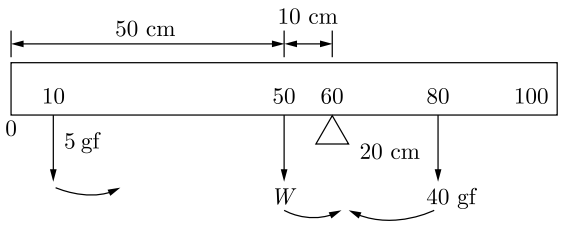
$$60 = 40 \times d$$

$$d = \frac{60}{40} = \frac{3}{2} = 1.5 \text{ m}$$

Thus (a) is correct option.

51. A uniform metre scale is balanced at 60 cm mark, when weights of 5 gf and 40 gf are suspended at 10 cm mark and 80 cm mark respectively. Calculate the weight of the metre scale.
(a) 25 gf (b) 15 gf
(c) 37 gf (d) 55 gf

Ans : SQP 2018



Let w be the mass of metre scale acting a mid point 50 cm.

$$\text{Clock wise moment} = 40 \times (80 - 60)$$

$$= 40 \times 20$$

$$= 800 \text{ gf cm} \quad ...(1)$$

Anticlockwise moments

$$= 5 \times (60 - 10) + w \times (60 - 50)$$

$$= (250 + 10w) \text{ gf cm} \quad ...(2)$$

$$\text{Anticlockwise moment} = \text{clock wise moment}$$

$$250 + 10w = 800$$

$$10w = 800 - 250 = 550$$

$$w = \frac{550}{10} = 55 \text{ gf}$$

Thus (d) is correct option.

52. A couple of 15 N force acts on a rigid body, such that the arm of couple is 85 cm. Calculate the moment of couple in S.I. system.
(a) 25.00 dyne (b) 15.80 dyne
(c) 37.50 dyne (d) 12.75 dyne

Ans : COMP 2023

$$\text{Force } F = 15 \text{ N}$$

$$\text{Arm of the couple} = 85 \text{ cm} = \frac{85}{100} \text{ m}$$

$$\text{Hence, Moment of the couple} = F \times \text{force arm}$$

$$= 15 \times \frac{85}{100}$$

$$= 12.75 \text{ Nm}$$

Thus (d) is correct option.

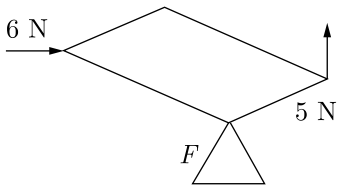
53. What type of motions are exhibited by a vehicle and its wheels?
(a) Translatory and rotatory
(b) Rotatory
(c) Translatory
(d) None of these

Ans : SQP 2022

As the vehicle is moving in forward direction, but wheels are revolving i.e., executing circular

motion.
Hence, option (a), a vehicle and its wheels execute translatory and rotatory motion.
Thus (a) is correct option.

54. A rectangular thin plate of dimension 3m × 4m is balanced on the fulcrum as shown below Find the resultant moment of force?



(a) 6 N-m clockwise
(b) 5 N-m anticlockwise
(c) 9 N-m anticlockwise
(d) 9 N-m clockwise

Ans : MAIN 2010

The longer length is the length of rectangle at which 6 N force acts producing a clockwise moment while 5 N force acts along the breadth of the rectangle producing anti clockwise moments. Use the sign convention and calculate the resultant force.
Thus (d) is correct option.

55. The gate of a building is 3 m broad. It can be opened by applying 100 N force at the middle of the gate. Calculate the least force required to open this gate, (at a point 6 m)
(a) 20 N (b) 30 N
(c) 50 N (d) 10 N

Ans : COMP 2011

Torque required to open the door will remain constant.

$$r_1 \times F_1 = r_2 \times F_2$$
$$3 \times 100 = 6 \times F_2$$
$$F_2 = \frac{3 \times 100}{6} = 50 \text{ N}$$

Thus (c) is correct option.

56. A practice of mass m is executing a uniform circular motion on a path of radius r. If p is the magnitude of its linear momentum, then what is the radial force acting on the particle?
(a) $\frac{p}{m}$ (b) $\frac{r_m}{p^2}$
(c) $\frac{r}{p}$ (d) $\frac{p^2}{mr}$

Ans : SQP 2017

Mass of the particle $= m$
As, the particle is executing a uniform circular motion, it will be accelerated with $\frac{v^2}{r}$ directed towards the centre as it is moving with a circle of radius r and moving with uniform speed.
According to Newton's second law of motion,

Centripetal force, $F_c = \frac{mv^2}{r}$

Rearranging, it can be written as,

$$F_c = \frac{mv^2}{r} \cdot \frac{m}{m}$$
$$= \frac{(mv)^2}{mr} = \frac{p^2}{mr}$$

Thus (d) is correct option.

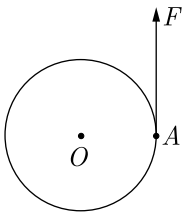
57. 10^{-10} Nm is equal to ..... dyne cm.
(a) 0.001 (b) 10^{-4}
(c) 10 (d) None of these

Ans : COMP 2014

$$1 \text{ Nm} = 10^7 \text{ dyne cm}$$
$$10^{-10}\text{Nm} = 10^7 \times 10^{-10}$$
$$= 10^{-3} = 0.001 \text{ dyne-cm}$$

Thus (a) is correct option.

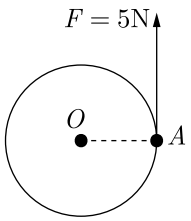
58. The diagram along side shows a force $F = 5$ N acting at point A produces a moment of force of 6 Nm about point O. What is the diameter of the wheel ?



(a) 3.4 m (b) 2.4 m
(c) 4.6 m (d) 1.0 m

Ans : SQP 2004

Force, $F = 5$ N
Moment of force $= 6$ Nm



Downloaded from www.pdf.tube

$$r = OA = ?$$

$$\text{Moment of force} = \text{Force} \times \text{OA}$$

$$6 = OA \times 5$$

$$OA = \frac{6}{5} = 1.2 \text{ m}$$

Hence, $\text{diameter} = 2r$

$$= 2 \times 1.2 = 2.4 \text{ m}$$

Thus (b) is correct option.

59. Two particles of equal masses are revolving in circular paths of radii r_1 and r_2 respectively, with the same speed. The ratio of their centripetal forces is

(a) $\left(\frac{r_1}{r_2}\right)^2$ (b) $\sqrt{\frac{r_2}{r_1}}$

(c) $\left(\frac{r_2}{r_1}\right)^2$ (d) $\frac{r_2}{r_1}$

Ans : MAIN 2006

Centripetal force is given by,

$$F_C = \frac{mv^2}{r}$$

Where, m = mass of the particle

v = velocity of the particle

r = radius of circular path

Now according to the question,

For mass m_1, $F_1 = \frac{m_1 v_1^2}{r_1^2}$ ...(i)

For mass m_2, $F_2 = \frac{m_2 v_2^2}{r_2^2}$ ...(ii)

Hence, the ratio of their centripetal force is obtained dividing equation (i) and (ii). Hence,

$$\frac{F_1}{F_2} = \frac{\frac{m_1 v_1^2}{r_1}}{\frac{m_2 v_2^2}{r_2}}$$

But as the masses of both the particles are same i.e., $m_1 = m_2 = m$ and speeds are same i.e., $v_1 = v_2 = v$

Then,

$$\frac{F_1}{F_2} = \frac{mv^2}{r_1} \times \frac{r_2}{mv^2} = \frac{r_2}{r_1}$$

Thus (d) is correct option.

60. The perpendicular distance between the point of application of force and the turning point is 1.75 m, when a force of 80 N acts on a rigid body. Calculate the moment of force.

(a) 370 Nm (b) 180 Nm

(c) 220 Nm (d) 140 Nm

Ans : COMP 2019

$$\text{Perpendicular distance} = 1.75 \text{ m}$$

$$\text{Force } F = 80 \text{ N}$$

$$\text{Moment of force} = F \times \text{perpendicular distance}$$

$$= 80 \times 1.75$$

$$= 140.00 = 140 \text{ Nm}$$

Thus (d) is correct option.

61. Calculate the length of the arm of couple, if a force of 13 N produces a moment of couple of 14.3 Nm.

(a) 2.75 m (b) 3.75 m

(c) 1.1 m (d) 1.5 m

Ans : SQP 2018

$$\text{Force, } F = 13 \text{ N}$$

$$\text{Moment of couple} = 14.3 \text{ Nm}$$

$$\text{Moment of couple} = F \times \text{arm of couple}$$

$$14.3 = 13 \times \text{arm of couple}$$

$$\text{Hence, Arm of couple} = \frac{14.3}{13} = 1.1 \text{ m}$$

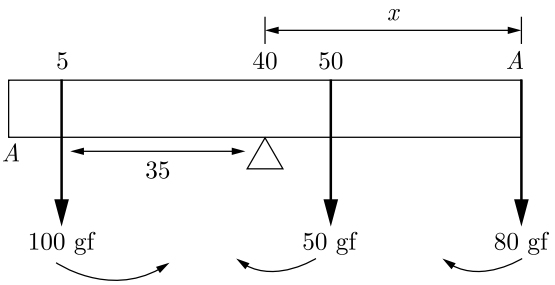
Thus (c) is correct option.

62. A uniform metre scale of weight 50 gf is balanced at the 40 cm mark, when a weight of 100 gf is suspended at the 5 cm mark. Where must a weight of 80 gf be suspended to balance the metre scale ?

(a) 66.00 cm (b) 70.00 cm

(c) 77.5 cm (d) 10.00 cm

Ans : COMP 2014



Let a wt. of 80 gf be placed at a distance x from 40 cm mark.

$$\text{Clock wise moments} = \text{Anticlockwise moment}$$

$$(80 \times x) + 50 \times (50 - 40) = 100 \times (40 - 5)$$

$$80x + 500 = 3500$$

$$80x = 3500 - 500$$

$$= 3000$$

$$x = \frac{3000}{80} = 37.5 \text{ cm}$$

Hence, A is at $40 + 37.5 = 77.5$ cm mark
Thus (c) is correct option.

63. Essential characteristic of equilibrium is
(a) Kinetic energy is equals to zero.
(b) Velocity equals to zero.
(c) Acceleration equals to zero.
(d) Momentum equals to zero.

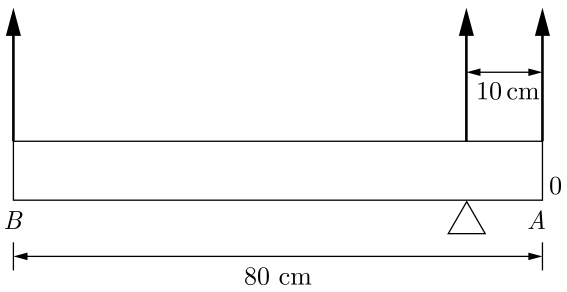
Ans : MAIN 2012

Essential characteristics of equilibrium is the total force i.e., the vector sum of ail forces acting on the rigid body is zero.

i.e., $\sum_{i=1}^{n} F_i = 0 = F_1 + F_2 + ... + F_n$

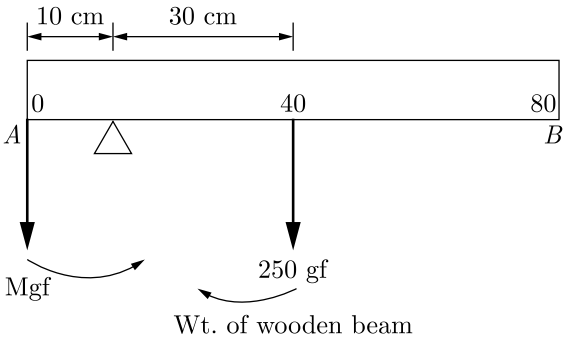
As mass cannot be zero, hence acceleration equals to zero.
Thus (c) is correct option.

64. A uniform wooden beam AB, 80 cm long and weighing 250 gf, is supported on a wedge as shown in the figure. Calculate the greatest weight which can be placed on end A without causing the beam to tilt.



(a) 375 gf (b) 560 gf
(c) 750 gf (d) 100 gf

Ans : SQP 2015



Let M gf be suspended at A as shown in the above figure. Hence,

Anticlockwise wise moment = clockwise moment

$$M \times 10 = 250 \times (40 - 10)$$

$$M = \frac{250 \times 30}{10} = 750 \text{ gf}$$

Thus (c) is correct option.

65. Force in linear motion has its analogue in rotational motion ?
(a) Torque
(b) Angular momentum
(c) Weight
(d) Moment of inertia

Ans : MAIN 2007

Force in linear motion has its analogue with torque in rotational motion, because moment of force = force $\times$the perpendicular distance of the line of action of the force moving towards the point.
Thus (a) is correct option.

ASSERTION AND REASON

66. **Assertion :** Uniform circular motion is an accelerated motion.
Reason : In uniform circular motion, an object moves with constant speed but variable velocity.
(a) Both assertion and reason are true.
(b) Both assertion and reason are false.
(c) Assertion is false but reason is true.
(d) Assertion is true but reason is false.

Ans :

In uniform circular motion, the body moves with constant speed in circular path, but its direction of motion keeps on changing continuously. Thus, the velocity of the object in uniform circular motion is variable and such motion is called accelerated motion.
Thus (a) is correct option.

67. **Assertion :** The moment of force for force 10 N applied at a distance of 20 cm from the pivot will be 0.02 Nm.
Reason : The moment of force is ratio of perpendicular distance of the line of action of the force for axis of rotation and magnitude of force.
(a) Both Assertion and reason are true
(b) Both Assertion and reason are false
(c) Assertion is false but reason is true
(d) Assertion is true but reason is false

Ans :

The moment of force is the product of

Click Here to Buy book on Amazon

perpendicular distance of the line of action of the force for axis of rotation and magnitude of force.

$$F = 10 \text{ N}, r = 20 \text{ cm} = 0.2 \text{ m}$$

Moment of force $= F \times r = 10 \times 0.2 = 2$ Nm

Thus (b) is correct option.

68. **Assertion :** The moment of force depends upon magnitude of the force applied and the perpendicular distance of the line of action of force from the axis of rotation.
Reason : The opening and shutting of the door is possible due to the moment of force.
(a) Both assertion and reason are true
(b) Both assertion and reason are false
(c) Assertion is true but reason is false
(d) Assertion is false but reason is true

Ans :

The turning effect on the body about its axis is due to the moment of force or torque applied on the body. To open and shut the door the force is applied normally on the door at its handle which provided at the maximum distance from the hinges.
Thus (a) is correct option.

69. **Assertion :** A duster lying on the table is an example of static equilibrium.
Reason : When a body remains in the same state of motion under the influence of several forces then the body is in static equilibrium.
(a) Both assertion and reason are true
(b) Both assertion and reason are false
(c) Assertion is false but reason is true
(d) Assertion is true but reason is false

Ans :

When a body remains in a state of rest under the influence of several forces, then the body is in static equilibrium. Thus, the duster which lie on the table in state of rest is the example of static equilibrium.
When a body remains in the same state of motion under the influence of several forces then the body is said to be in dynamic equilibrium.
Thus (d) is correct option.

70. **Assertion :** When a force acts on a stationary rigid body which is free to move and if body starts moving in straight path in direction of applied force, then it is said to be linear motion.
Reason : If free body is acted upon by two unequal forces in opposite direction, but not in one line, the effect is that the body will possess rotational motion only.
(a) Both assertion and reason are true
(b) Both assertion and reason are false
(c) Assertion is false but reason is true
(d) Assertion is true but reason is false

Ans :

Linear motion is also known as translational motion. When force acting on stationary object makes it to move in a straight path then the body is said to have translational or linear motion.
And when a free body is acted upon by two unequal forces in opposite direction, but not in one line, then the body possesses both rotational as well as translational motion.
Thus (d) is correct option.

ONE MARK QUESTIONS

DIRECTION : Fill in the blanks :

71. When a stone tied to a string is rotated in a horizontal plane, the tension in the string provides ..... force necessary for circular motion. (Centripetal, centrifugal)

Ans : MAIN 2024

Centripetal

72. In a beam balance when the beam is balanced in a horizontal position, it is in ..... equilibrium. (stable/unstable)

Ans : MAIN 2015

Stable

73. A ..... handle with a screw jack is used so that the required force decreases. (Long/short)

Ans : SQP 2023

Long

74. The centre of gravity of a ..... (Uniform/ Non Uniform) ring is situated at its geometrical centre.

Ans : MAIN 2015

Uniform

75. ..... is defined as a set of two equal and opposite forces acting along different lines of action. (Couple/Moment).

Downloaded from www.pdf.tube

Ans : MAIN 2019

Couple

76. The centre of gravity of an object of given mass depends on its ..... (shape/Density)

Ans : MAIN 2016

Shape

DIRECTION : Answer the following :

77. Name the unit of physical quantity obtained by the formula $2\,K/V^2$, where K : Kinetic energy, V : Linear velocity.

Ans : COMP 2000

$Js^{-2}m^{-2}$.

78. Where is the centre of gravity of a uniform ring situated ?

Ans : COMP 2013

At its geometric centre.

79. What do you mean by kilogram force and write its relation with newton?

Ans : MAIN 2015

One kilogram force (kg f) is the force required to lift a body of mass 1 kilogram.

$$1 \text{ kg } f = 9.8 \text{ N}$$

80. Which type of motions are exhibited by a vehicle and its wheels?

Ans : SQP 2010

The motion of vehicle is translatory and the motion of wheels is rotatory.

81. Why do we use a long handle with a screw jack ?

Ans : COMP 2007

A long handle with a screw jack is used so that the required force decreases.

82. What do you mean by axis of rotation?

Ans : SQP 2005

Axis of rotation is the line or point about which the object rotates. It may be within the object or outside the object.

83. On what factor does the position of the centre of gravity of a body depend?

Ans : SQP 2015

Distribution of mass.

84. The position of the centre of gravity of a body remains unchanged even when the body is deformed.' State whether the statement is true or false.

Ans : COMP 2013

False

85. Where is the centre of gravity of a uniform ring situated?

Ans : MAIN 2000

The centre of gravity of a uniform ring is situated at its geometrical centre.

86. What is the SI unit of the moment of force?

Ans : COMP 2015

N-m.

87. Define equilibrium.

Ans : SQP 2015

It is a state in which net force acting on a body or system is zero.

88. Why do we use a long handle with a screw jack?

Ans : COMP 2012

In a screw jack, a long handle helps us to apply less force F at a good distance from the axis of rotation making $d_\perp$ large so as to give a large turning effect.

89. Can the couple acting on a rigid object produce translatory motion?

Ans : MAIN 2014

No, the couple acting on a rigid object cannot produce translatory motion, it can cause only rotatory motion.

90. A small coin is placed on a rotating record. The coin does not slip on the record. Where does it get the centripetal force from ?

Ans : SQP 2020

The necessary centripetal force is provided by the force of friction between the coin and the record.

91. Can the centre of gravity of a body be outside it? If yes, give one example.

Ans : MAIN 2021

Yes, the CG of a body can be outside the body.

NODIA

The CG of a uniform ring is at its centre, a point which is not on the body.

92. What do you mean by axis of rotation?

Ans : COMP 2017

Axis of rotation is the line or point about which the object rotates. It may be within the object or outside the object.

93. Can the moment of a force be zero even if the force is not zero? If so, when?

Ans : SQP 2018

Yes, if the line of action passes through the point about which moment is to be calculated.

94. Why is it easier to open the cap of a pen with two fingers than with one finger?

Ans : MAIN 2000

This is so because when we use two fingers, a couple is formed. This couple enables us to open the cap of the pen easily.

95. Why it is difficult to open the door by pushing it or pulling it at the hinge ? Explain.

Ans : COMP 2015

This is so because near the hinge, the distance of the point of application of force from the axis of rotation becomes negligible, so the force applied increases.

96. Can a simple machine act as a force multiplier and speed multiplier simultaneously in the same machine?

Ans : SQP 2018

No, Machines which are force multipliers do not gain in speed and vice-versa.

97. What types of motions are executed by a vehicle and its wheels ?

Ans : COMP 2011

The vehicle executes translatory but the wheels execute rotatory motion.

98. Mention the names of a few bodies which can be considered as rigid bodies for practical purposes.

Ans : COMP 2017

In actual practice a rigid body is not possible but for practical purposes stone, metal, glass and wood are considered as rigid bodies.

TWO MARKS QUESTIONS

99. A hollow ice cream cone has height 6 cm.
1. Where is the position of its centre of gravity from the broad base?
2. Will its position change when it is filled completely with honey? Write Yes or No.

Ans : MAIN 2024

1. The centre of gravity from the broad base is at a height $\frac{h}{3} = \frac{6}{3} = 2$ cm.
2. Yes.

100. (i) Define moment of force.
(ii) Write the relationship between SI and CGS unit of moment of force.

Ans : SQP 2020

(i) It is defined as the product of force and the arm of the couple.
(ii) 1 nm $= 10^7$ dyne-cm.

101. (i) Define couple.
(ii) State its SI unit.

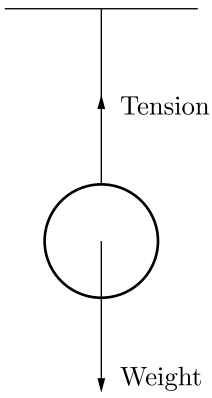
Ans : MAIN 2019

(i) It is defined as a set of two equal and opposite forces acting along different lines of action.
(ii) SI unit is N m.

102. A brass ball is hanging from a stiff cotton thread. Draw a neat labelled diagram showing the forces acting on the brass ball and the cotton thread.

Ans : COMP 2017

The diagram is as shown :



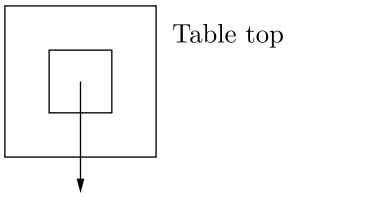
103. Why are railway wagons not loaded beyond a certain limit?

Ans : COMP 2005

Click Here to Buy book on Amazon

Railway wagons are not loaded beyond a certain limit because it raises the centre of gravity of the wagon. Thus, while going around the sharp turns, the line joining the centre of gravity and centre of the earth may falls outside the base of the wagon which can cause derailment.

104. When a body is placed on a table top, it exerts a force equal to its weight downwards on the table top but does not move or fall.



(i) Name the force exerted by the table top.
(ii) What is the direction of the force ?

Ans : COMP 2015

(i) Reaction force.
(ii) Upwards.

105. Is it possible to have an accelerated motion with a constant speed? Explain.

Ans : SQP 2014

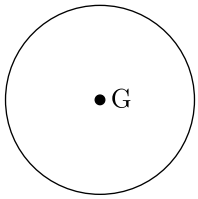
Yes, it is possible to have accelerated motion with a constant speed. For example, in a uniform circular motion, the body moves with constant linear speed with a constant centripetal acceleration acting towards the centre of the circle.

106. Give any two effects of a force on a non-rigid body.

Ans : MAIN 2000

Force when applied on a non-rigid body can :
(i) change the dimensions (shape/size) of body.
(ii) cause motion in the body.

107. 'The position of the centre of gravity of a body remains unchanged even when the body is deformed.' State whether the statement is true or false.



Ans : SQP 2020

False (Because position of centre of gravity of a body depends on distribution of mass in it so, if body is deformed mass distribution varies and so position of centre of gravity also varies).

108. On what factor does the centre of gravity of an object depend? Give the example of objects whose centre of gravity lie outside the object.

Ans : MAIN 2009

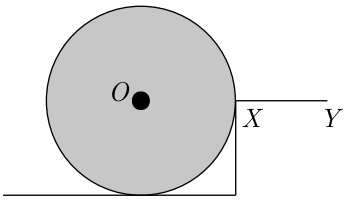
The centre of gravity of an object of given mass depends on its shape, e.g., the centre of gravity of a wire is at its mid-point but if this wire is bent into the form of a circle, its centre of gravity will be at the centre of the circle. Other examples in which centre of gravity lies outside the material are centre of gravity of ring, hollow sphere, L-shaped objects, etc.

109. Where does the position of centre of gravity lie for:
(a) a circular lamina,
(b) a triangular lamina?

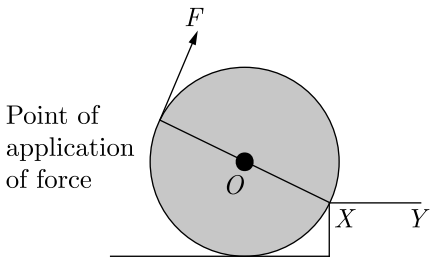
Ans : MAIN 2011

(a) The position of centre of gravity for a circular lamina lies at the geometric centre.
(b) For a triangular lamina, the position of centre of gravity lies at the centroid or point of intersection of medians.

110. Given figure shows a heavy roller with axle at O which is to be pulled on to pavement XY by applying minimum possible force. Draw the diagram and mark the direction in which the force should be applied.



Ans : SQP 2000



NODIA

111. What is meant by the term 'moment of force'?

Ans : MAIN 2001

Moment of force produced by a force about an axis is equal to the product of the magnitude of force and its lever arm about the axis. It is represented by t.

$$\text{Torque, } (\tau) = \text{Force } (F) \times \text{Lever arm } (d_\perp)$$

112. Give any two effects of a force on a non-rigid body.

Ans : COMP 2013

Effects of a force on a non-rigid body:
(i) can change the dimension of the body.
(ii) can start/stop the motion of the body.

113. Why are the passengers not allowed to stand in a small boat while crossing a river?

Ans : MAIN 2018

Passengers are not allowed to stand in a small boat because standing raises the centre of gravity of the boat, due to which line joining the centre of gravity and the centre of the earth may fall outside the base of the boat crossing the river. Thus, boat can capsize.

114. Why skidding takes place usually on a rainy day along a curved path?

Ans : MAIN 2003

Skidding takes place on a rainy day because the force of friction between the road and the tyres considerably decreases and is not sufficient to supply the necessary centripetal force.

115. If the moment of force is assigned a negative sign then will the turning tendency of the force be clockwise or anticlockwise?

Ans : SQP 2000

If the moment of force is assigned a negative sign, the turning tendency of the force will be clockwise.

116. Force is applied on a body capable of rotation about an axis, yet no rotation occurs. Explain.

Ans : COMP 2009

The effect of a force applied on a body depends upon the line of action of the force. There will be no turning moments of a force, if its line of action passes through the axis of rotation and hence no rotation takes place.

117. How do you assign the sign to clockwise/anti-clockwise moment of force?

Ans : SQP 2007

Moment of force is assigned a positive sign if the turning tendency of the force is anticlockwise and a negative sign if turning tendency of the force is clockwise.

118. Self-erecting toy or rolly polly doll is made heavier at the base. Explain why.

Ans : SQP 2010

Self-erecting toy or rolly polly doll is made curved and heavily loaded at its base so that its centre of gravity remains lowest in the vertical position. Thus, when it is turned even through an angle of 90°, its centre of gravity is raised and falls within the base of toy. When external force is removed from the toy, it regains its stable equilibrium, i.e. becomes erect.

119. Why does a coolie carrying load on his back bend forward?

Ans : MAIN 2015

A coolie carrying load on his back has to lean forward to bring down the centre of gravity of the load and himself as low as possible and to keep the vertical line passing through the centre of gravity of the whole system between his feet. Hence he remains in stable equilibrium.

120. What do you mean by (a) a rigid object and (b) a non-rigid object?

Ans : COMP 2020

(a) A rigid object is one in which the constituent atoms/molecules are strongly bound to each other and the object does not budge under the action of ordinary force, e.g., steel, etc.
(b) A non-rigid object is one which changes its shape and/or size when a force acts on it, e.g., wet clay, putty, etc.

121. What is meant by equilibrium ? State the necessary conditions for a body to be in equilibrium.

Ans : SQP 2023

A body is said to be in equilibrium under the action of a number of forces, if the forces are not able to produce any change in the state of rest or of uniform motion or uniform rotation. For a body to be in equilibrium, the following conditions must be satisfied :

Downloaded from www.pdf.tube

(i) Vector sum of all the forces acting on the body must be zero, i.e., $\sum F_i = 0$.
(ii) Vector sum of all the torques of the different forces must also be zero, i.e., $\sum \tau_i = 0$.

122. What will happen to the Earth, if the Sun stops to attract the Earth ?

Ans : COMP 2015

The force of gravitation between the Earth and the Sun keeps Earth in its orbit around the Earth. If the Sun does not attract the Earth, it will move in a straight line tangent to path at the time of motion.

123. To pull open a heavy gate using minimum force where and in what direction the force should be applied? Why ?

Ans : MAIN 2012

Moment of force= Force $\times$ Perpendicular distance
For a given force, the torque will be maximum, if perpendicular distance is maximum. The force should be, therefore, applied in a direction perpendicular to the plane of the gate.

124. Explain briefly the role of the position of CG in
(a) loading a ship
(b) sitting/standing on the upper deck of a bus.

Ans : SQP 2004

(a) **Loading a ship :** Cargo is loaded in the lowest deck of a ship. This considerably lowers the CG and hence the turning moments of the weight also decrease. This increases the stability of the ship.
(b) **Sitting/Standing on the upper deck of a bus :** Passengers are usually advised not to stand in the upper deck of the double deck bus. When the passengers are standing, the CG rises. This decreases the stability of the bus. When the passengers are sitting, the CG gets lowered and stability of the bus increases.

125. Is torque a scalar or a vector quantity ? If vector, what is its direction ?

Ans : COMP 2010

Torque is a vector quantity. Its direction is along the axis of rotation, i.e., perpendicular to the plane of rotation.

126. Explain why does one lean forward while climbing up a hill.

Ans : COMP 2003

When a person climbs up a hill, he bends himself in the forward direction and adjusts his centre of gravity in such a way that the vertical line joining the centre of gravity and the centre of the earth falls within the base of his feet. Thus, the condition of stable equilibrium is satisfied and the person does not fall.
Due to similar reason a person coming down a hill bends backwards.

127. What do you mean by the terms
(i) translational motion and
(ii) rotational motion?

Ans : SQP 2009

(i) In translational motion on application of a force; the object starts moving bodily with all its particles moving along parallel lines in the direction of force with the same speed.
(ii) In rotatory motion, when a force is applied on an object at a fixed point, the object starts rotating about that point with its particles moving along concentric circles with different speeds.

128. Why are the racing cars very broad and very low in height?

Ans : MAIN 2008

Racing car is specially designed with a very broad base and very low in height which keeps its centre of gravity very low. Thus, when this car takes sharp turn, at very high speed, the vertical line joining its centre of gravity and centre of the earth always falls within its base, which keeps it in stable equilibrium.

129. Give a few examples of couple.

Ans : COMP 2004

Rotation of an object is due to couple. Few examples of couple are: turning a water tap, tightening of the cap of an ink-pot, winding a clock with the key, steering of a four wheeler, driving the pedal of a bicycle, opening of a door (rotation is produced by the force we exert and an equal and opposite reaction at the hinge).

130. Define moment of a force about an axis.

Ans : SQP 2002

The moment of a force about an axis of rotation is the turning effect of the force about the axis of rotation. It is measured by the product of the force and the perpendicular distance between the

NODIA

axis of rotation and the line of action of the force.

131. What are the factors on which rotational effect of a force depends?

Ans : MAIN 2009

Rotational effect of a force depends on two factors, viz.
(i) the magnitude of the force (F), and
(ii) perpendicular distance of its line of action from the axis or point about which rotation is taking place.

132. What do you understand by equilibrium? Can an object be acted upon by several forces in equilibrium? If yes, name the type of equilibrium.

Ans : COMP 2010

An object is said to be in equilibrium if a number of forces acting on it produce no change in its state of rest or of uniform motion (translational or rotational).
Yes, static equilibrium and dynamic equilibrium.

133. Distinguish between linear acceleration and centripetal acceleration.

Ans : COMP 2007

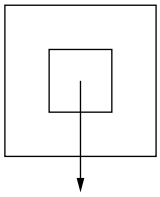
Linear acceleration is defined as the rate of change of linear velocity whereas centripetal acceleration is defined as the rate of change of velocity in circular motion. This acceleration acts towards the centre of the circular path along its radius.

134. A force produces change in linear motion or translation of a body. What does the moment of a force do?

Ans : SQP 2006

The moment of a force produces a change in the rotational motion of the body, i.e., produces angular acceleration of the body.

135. When a body is placed on a table top, it exerts a force equal to its weight downwards on the table top but does not move or fall.



(i) Name the force exerted by the table top.
(ii) What is the direction of the force?

Ans : SQP 2014

(i) Force exerted by the table top on the body is normal reaction force.
(ii) The direction of the force is vertically upwards.

136. Why is heavy luggage loaded near the bottom of a ship?

Ans : MAIN 2005

Ship is loaded with heavy luggage near the bottom to lower down the centre of gravity. Hence the line joining the centre of gravity and the centre of earth does not fall outside the base of the ship when it pitches or rolls in the sea. Thus, it stays in stable equilibrium.

137. If a large force is acting on an object such that its line of action passes through the point about which the object can rotate. What will be your inference about the approximate magnitude of the moment of force?

Ans : COMP 2012

Torque (τ) = force $(F)\times$ perpendicular distance (d) from the axis of rotation
Here $d = 0 \Rightarrow t = 0, i.e$ moment of force will be zero.

138. Why a couple acting on a rigid body cannot produce translatory motion ?

Ans : SQP 2016

A couple is always formed by two equal and opposite forces. The resultant force is, therefore, always zero. Hence, no linear motion can be produced by a couple.

139. Name the factor affecting the turning effect of a body.

Ans : MAIN 2016

Factors affecting the turning effect of a body are:
(i) magnitude of the force applied.
(ii) perpendicular distance of line of action of the force.

140. What do you mean by kilogram force and write its relation with newton?

Ans : MAIN 2017

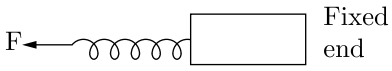
One kilogram force (kg f) is the force required to

Click Here to Buy book on Amazon

lift a body of mass 1 kilogram.

$$1 \text{ kg } f = 9.8 \text{ N}$$

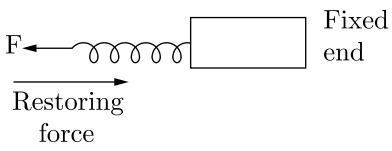
141. One end of a spring is kept fixed while the other end is stretched by a force as shown in the diagram :



(i) Copy the diagram and mark on it the direction of restoring force.
(ii) Name one instrument which works on the above principle.

Ans : COMP 2013

(i)

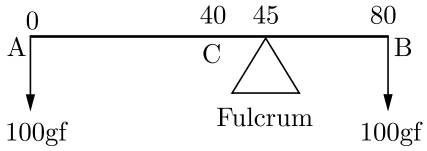


Force applied and restoring force both act on opposite directions.

(ii) Spring balance works on this principle, i.e., extension produced in the string is directly proportional to the weight (force) applied on it and the direction of extension (restoring force) is opposite to it.

THREE MARKS QUESTIONS

142. A metal rod AB of length 80 cm is balanced at 45 cm from the end A with 100 gf weights suspended from the two ends.



(a) If this rod is cut at the centre C, then compare the weight of AC to the weight of BC.
(b) Give a reason for your answer in (a)

Ans : SQP 2025

(a) Weight of AC $<$ weight of BC
(b) Even though the weights present are the same at both ends the torque arm of B is less than the torque arm of A.
This means the moment of the weight of the rod acts from side B and the C.G. lies beyond 45. Thus, more weight is concentrated between C to B.

143. A stone of mass 'm' is rotated in a circular path with a uniform speed by tying a strong string with the help of your hand. Answer the following questions :
(i) Is the stone moving with a uniform or variable speed ?
(ii) Is the stone moving with a uniform acceleration ? In which direction does the acceleration act?
(iii) What kind of force acts on the hand and state its direction ?

Ans : COMP 2016

(i) Uniform speed.
(ii) Yes, towards the centre of the circular path.
(iii) Centrifugal outwards.

144. Why are passengers travelling in a double-decker bus allowed to stand on the lower deck but not on the upper deck?

Ans : MAIN 2005

Passengers travelling in the double-decker bus are allowed to sit or stand only on the lower deck which ensures lowering of the centre of gravity. On the other hand, if the passengers are standing on the upper deck, the centre of gravity of the bus will be raised to the extent that the line joining the centre of gravity of the bus and the centre of the earth can fall outside the base of bus along the sharp turns and hence it can topple over.

145. Name the factors affecting the turning effect of a body.

Ans : SQP 2008

(i) Magnitude of force.
(ii) Distance of point of application of force from the axis of rotation.
(iii) Angle between force and distance from axis of rotation.

146. Explain why a rope walker holds a long pole in his hands.

Ans : COMP 2013

When a rope walker walks on the tight rope, he holds a long pole in his hands to stay on the rope. For this the line joining the centre of gravity and centre of earth must fall with the rope. When rope walker feels he is falling towards right, he

NODIA

then shifts pole towards left by keeping his centre of gravity undisturbed. Thus, he can balance himself on the rope.

147. Why is it easy to carry two buckets in one hand each, rather than to carry only one bucket in one hand?

Ans : SQP 2016

When a person carries only one bucket in his one hand, his centre of gravity shifts towards the bucket and vertical line passing through its centre of gravity may fall outside his feet. However, if in both the hands buckets are carried, the centre of gravity is lowered and it falls within the feet due to which a person stays in stable equilibrium.

148. How will you find the centre of gravity of an irregular lamina? Explain.

Ans : MAIN 2000

Determination of centre of gravity of an irregular lamina:

To determine the centre of gravity of a given irregular lamina make three holes a, b and c near the circumference of lamina.

Now suspend the given lamina freely from hole 'a'along with a plumb line. When the lamina is in the rest state draw a straight line 'ae' along the plumb line. Now suspend the lamina through hole 'b' and then through hole 'c'. Draw lines 'bf and 'cd'. Thus, three lines ae, bf and cd intersect at a common point G which is the position of the centre of gravity of the lamina.

149. Explain the following :

(a) You always keep your feet wide apart when receiving the charge from an opponent at football.

(b) It is easier to knock over a person who is standing on one foot than one who is standing on two.

(c) Why do the wine glasses have a heavy and broad base?

Ans : SQP 2000

(a) While receiving the charge from an opponent, at football, we keep our feet wide apart to adjust the centre of gravity as low as possible to position ourselves in stable equilibrium. Thus, on hitting we do not fall. Similarly, players do the same while playing cock-fighting.

(b) It is easier to knock over a person who is standing on one foot than one who is standing on two because the person standing on one foot has a smaller base area than the person standing on both the feet. Thus, the person standing on one foot is in a less stable equilibrium and easily knocked down.

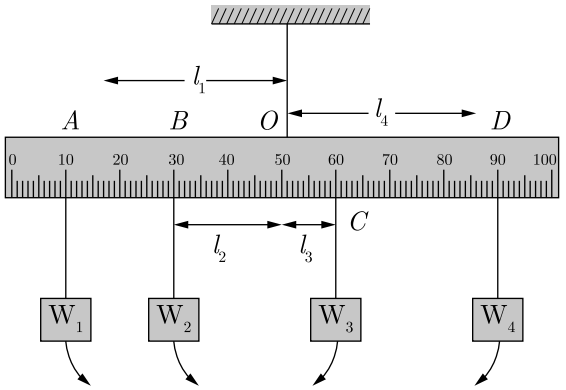
(c) Wine glass has a broad and heavy base because the heavy base lowers its centre of gravity and broad base will adjust the line joining the centre of gravity and centre of the earth fall within the base and keep the glass in stable equilibrium. Due to similar reason, base of bunsen burner, table lamp, flask and bottle, etc., have a heavy and broad base.

150. State the principle of moments. How will you verify this principle if you are supplied with a metre rule, a fulcrum and a weight box?

Ans : MAIN 2011

According to the principle of moments, the sum of anticlockwise moments of forces about any point must be equal to the sum of the clockwise moments of the forces about the same point.

Suspend a metre rule horizontally from its mid-point O by means of a thread loop with its other end connected to a fixed support. Now suspend some weights on both sides of the mid-point. Adjust their distances in such a way that the ruler again becomes horizontal. Let the weights are suspended as shown in figure.



Verification of principal of moments

In equilibrium

Total anticlockwise moment

= Total clockwise moment

$$w_1 \times l_1 + w_2 \times l_2 = w_3 \times l_3 + w_4 \times l_4$$

This verifies the principle of moments.

151. Why is a cart loaded with hay more likely to be upset than one loaded with steel?

NODIA

Ans : COMP 2010

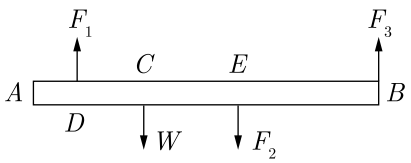
When a cart/truck is loaded with hay its centre of gravity is sufficiently raised. While the centre of gravity of cart/truck loaded with steel is lowered. When the hay loaded cart will take sharp turn/ or moves on uneven road, vertical line passing through its centre of gravity may go outside the base of the cart/truck and it is more likely to topple than the cart loaded with steel.

FOUR MARKS QUESTIONS

152. State and explain the principle of moments. Draw a diagram to illustrate.

Ans : COMP 2003

When a force acts on a body capable of rotation, it causes a rotation of the body either in the clockwise direction or anticlockwise direction. According to the principle of moments, when a number of forces act on body free to rotate about an axis and if no rotation occurs, then the sum of the clockwise moments must be equal to the sum of the anticlockwise moments. To illustrate the principle, let us consider a uniform rod AB of weight W, to be in equilibrium under the action of a number of forces F_1, F_2, F_3 and weight W acting at points D, E, B and C respectively, then according to the principle of moments :



Taking moments about A

Sum of clockwise moments = Sum of anticlockwise moments

$$W \times AC + F_2 \times AE = F_1 \times AD + F_3 \times AB$$

If we take moments about C, we will get

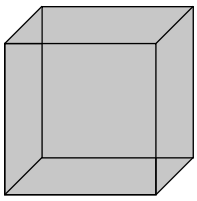
$$F_2 \times CE + F_1 \times CD = F_3 \times CB$$

153. Mention different states of equilibrium with examples and explain in each case the position of the centre of gravity which determines the nature of the equilibrium.

Ans : MAIN 2010

Stable equilibrium : An object is said to be in stable equilibrium if it has a tendency to return to its original equilibrium position after being slightly disturbed, *e.g.*, a cone lying on its base, bottle standing on its base, a book lying flat on a table, a person standing with his legs wide apart.

Stable

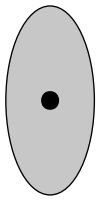


cube

Consider a cube resting on a horizontal surface. When the cube is tilted up slightly, its centre of gravity is raised but its moment of weight tends to bring the gravity down the lowest position. Therefore, cube comes back to its original position.

Unstable equilibrium : An object is said to be in unstable equilibrium if it does not regain its original equilibrium position after being slightly disturbed, *e.g.*, a cone standing on its apex, a bottle standing on its mouth, a book standing on its edge, a person standing on one leg, ellipsoid etc.

Unstable



Ellipsoid

Consider an ellipsoid resting on a smooth horizontal surface is displaced slightly from its position, its centre of gravity brings to descend and moment of weight tends to bring the centre of gravity lower down and hence, the ellipsoid moves away from its initial position.

Neutral equilibrium : An object is said to be in neutral equilibrium, if after being slightly disturbed, the object does not have any tendency either to regain its original equilibrium position or to tilt further from its new position, *e.g.*, a rolling ball, a person lying flat on the ground, a cone rolling on its curved surface, a bottle lying on its side etc.

FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

Downloaded from www.pdf.tube

ICSC CLASS 9

Previous Year Solved Exam Question Bank

Click your Subject and Instantly get a free PDF or Order the Hard copy from Amazon.

English Language

English Literature

Physics

Chemistry

Biology

Mathematics

Geography

History and Civics

Economics

Commercial Studies

Environmental Science

Physical Education

Computer Application

Economics Application

Commercial Application

Environ. Application

Home Science

Hindi

Robotics and AI

Yoga

For Other Subject PDF of all Classes, and for NEET, JEE and CUET visit

www.pdf.tube

ICSC CLASS 10

Previous Year Solved Exam Question Bank

Click your Subject and Instantly get a free PDF or Order the Hard copy from Amazon.

English Language	English Literature	Physics	Chemistry
Biology	Mathematics	Geography	History and Civics
Economics	Commercial Studies	Environmental Science	Physical Education
Computer Application	Economics Application	Commercial Application	Environ. Application
Home Science	Hindi	Robotics and AI	Yoga

BUY IT ON amazon

DOWNLOAD FREE PDF WWW.MCQGPT.COM

For Other Subject PDF of all Classes, and for NEET, JEE and CUET visit

www.pdf.tube

ISC CLASS 11

Previous Year Solved Exam Question Bank

Click your Subject and Instantly get a free PDF or Order the Hard copy from Amazon.

English Com

Mathematics

Physics

Chemistry

Biology

Physical Education

Environmental Science

Computer Science

Accountancy

Business Studies

Economics

Commerce

Legal Studies

Mass Media

Home Science

History

Geography

Political Science

Psychology

Sociology

For Other Subject of All Clasess PDF and for NEET, JEE and CUET visit

www.pdf.tube

ISC CLASS 12

Previous Year Solved Exam Question Bank

Click your Subject and Instantly get a free PDF or Order the Hard copy from Amazon.

English Com

Mathematics

Physics

Chemistry

Biology

Physical Education

Environmental Science

Computer Science

Accountancy

Business Studies

Economics

Commerce

Legal Studies

Mass Media

Home Science

History

Geography

Political Science

Psychology

Sociology

For Other Subject of All Clasess PDF and for NEET, JEE and CUET visit

www.pdf.tube

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

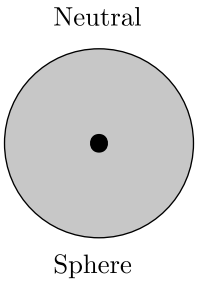
Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!



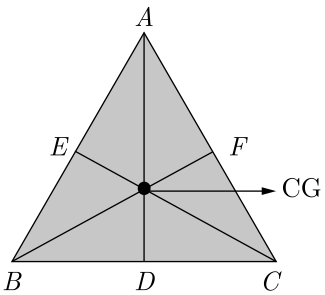
Consider a sphere resting on a horizontal surface is slightly disturbed from its initial position, its centre of gravity remains at the same level neither tends to come back to its original position nor topples over.

Thus, the above examples make it clear that to know whether a given object is in stable, unstable or neutral equilibrium, find whether the displacement tends to raise its centre of gravity, lower it or leave it unaffected.

154. Assuming the centre of gravity of a uniform rod to be at its mid-point, explain briefly how can you obtain the position of the centre of gravity of triangular lamina.

Ans : MAIN 2006

Consider a triangular lamina ABC. We can imagine the lamina to consist of a number of thin uniform rods as shown. Now, the CG of each thin rod lies at its centre. The centre of gravity of all these thin lamina will, therefore, lie on the median AD. Similarly, if divide the lamina into thin rods parallel to AB and AC, the CG will lie on the medians CE and BF respectively. Since CG of the lamina is a fixed point, it will lie on the point of intersection of the medians. The CG of the lamina, is thus, the point of intersection of the medians.



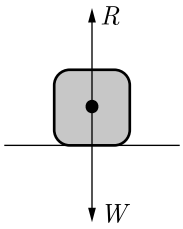
155. Give examples of an object to be in (a) static equilibrium and (b) dynamic equilibrium.

Ans : SQP 2009

Static equilibrium :

(i) In a beam balance, if the beam is balanced in the horizontal position, the clockwise moments balance anticlockwise moments and beam has no rotational motion, *i.e.* the beam is in static equilibrium.

(ii) If an object lying on the table is pulled by a force to its left and by an equal force to its right along the same line, the object does not move because the applied forces are equal and opposite and balance each other. Weight of the object is exerted on the table vertically downwards is balanced by equal and opposite reaction exerted by the table on the object vertically upwards. Thus the body is in static equilibrium.



Dynamic equilibrium :

(i) An object moving with uniform velocity (acceleration = 0) in a straight line over smooth surface is in dynamic equilibrium because weight of the object acting vertically downwards is balanced by an equal reaction exerted on the object by the surface vertically upwards. Thus, net force on the object is zero.

(ii) In an atom electron revolving round the nucleus is in dynamic equilibrium since the force of attraction on the electron by the nucleus provides the necessary force (called centripetal force) for circular motion and electron remains moving with uniform speed.

156. Explain the moment of a force with diagram and formula for (a) the steering wheel of a car, (b) the pedal and the rear wheel of a bicycle.

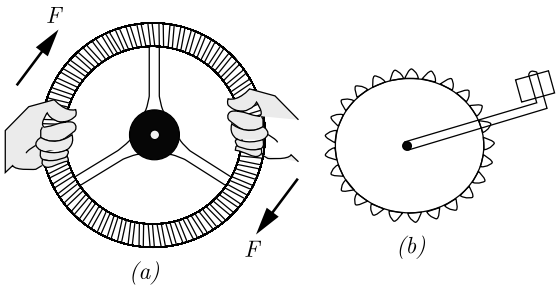
Ans : SQP 2010

The moment of a force is measured by the product of force and perpendicular distance between the axis of rotation and the line of action of the force.

i.e., $\tau = F \cdot d$

(a) In the case of the steering wheel, the left and the right hands apply equal and opposite forces, each equal to F and d is equal to the diameter of the steering wheel.

NODIA

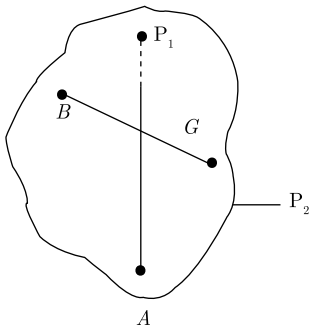


(b) In the case of a bicycle wheel, a small force is applied at the pedal which is at a large distance from the axle. Since in one revolution, the pedal moves through a larger distance, than the links of the chain, the applied force gets multiplied and is passed on to the rear wheel. The two pedals provide two such forces and form a torque which rotates the wheel.

157. Describe how would you determine experimentally the position of the centre of gravity of a thin sheet of material of irregular shape and of uniform thickness.

Ans : SQP 2010

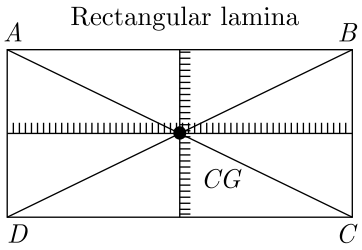
When a body is suspended from a support the moment of the weight rotates the body. The body rotates for sometime about the axis of rotation and is finally brought to rest. In this position, torque acting on it is zero and vertical line through the point of suspension passes through CG. To find the CG of a thin sheet of a material, suspended it from two holes through two different points P_1 and P_2 one at a time as shown. Draw vertical lines through the two points for which we get straight lines P_1A and P_2B and find the point of their intersection. This point of intersection G is the position of the centre of gravity of the lamina.



158. Draw sketch diagram and indicate the position of the centre of gravity of (a) rectangular lamina, (b) lamina of the shape of a parallelogram, (c) triangular lamina, (d) a thin disc, (e) a cylinder.

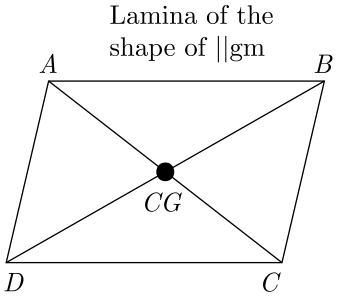
Ans : COMP 2005

(a)



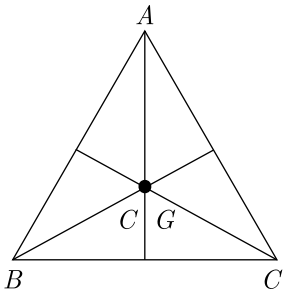
CG is the point of intersection of diagonals.

(b)



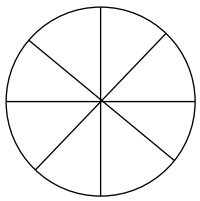
CG lies at the point of intersection of diagonalos.

(c)



CG lies at the point of intersection of medians.

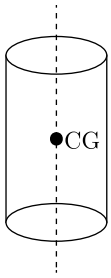
(d)



(Thin disc)
CG lies at the centre of the circular disc.

(e)

Click Here to Buy book on Amazon



A cylinder
Mid-point of the axis of the cylinder

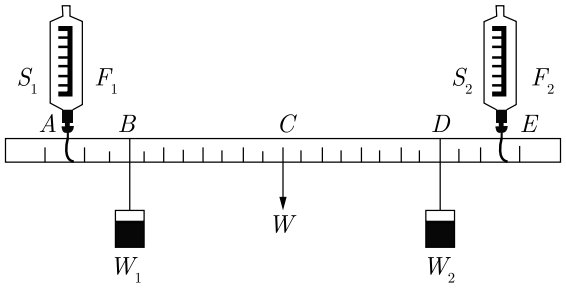
159. Explain briefly how can you verify the principle of moments.

Ans : MAIN 2015

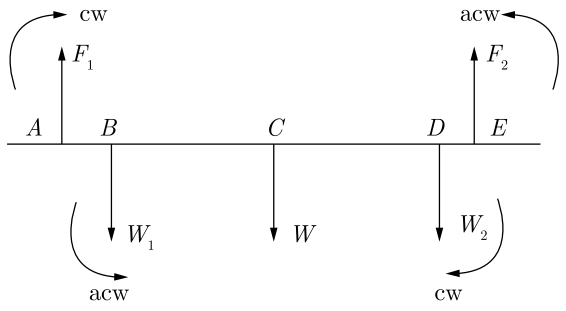
The principle of moments can be verified by using a metre scale and two spring balances. Suspend the metre scale by the two spring balances S_1 and S_2 as shown in figure. From the metre scale, suspend two hangers having slotted weights W_1 and W_2. The positions of the spring balances and the slotted weights are adjustable. Let C be the centre of gravity of the metre scale whose weight is W and acts downwards at the centre of gravity. Adjust the positions of the spring balances, note their readings. Let it be F_1 and F_2. Adjust the two slotted weights, so that the scale is in equilibrium.

(a) It will be seen that the sum of the upward forces = Sum of the downward forces i.e.,

$$F_1 + F_2 = W_1 + W_2 + W$$



(a)



(b) Diagrams used to verify the principle of moments.

(b) Consider figure (b), let us take the moments of forces about the point C. Clearly, moment of the force W is zero as the distance of its line of action from the point C is zero. The turning effects of the forces F_2 and W_1 about the point C are anticlockwise (acw) and the turning effects of the forces F_1 and W_2 are clockwise (cw). In equilibrium, we find that

$$F_2 \times CE + W_1 \times CB = F_1 \times CA + W_2 \times CD$$

Thus, the sum of all anticlockwise moments of forces = the sum of all clockwise moments of forces about the point C.

Hence, the principle of moments is verified.

160. State the conditions for an object to be in:
(a) stable equilibrium
(b) unstable equilibrium and
(c) neutral equilibrium.

Ans : COMP 2014

(a) Conditions for an object to be in stable equilibrium:
  (i) Base of the object should be broad.
  (ii) Base of the object should be heavy because it will lower its centre of gravity.
  (iii) When the object is slightly tilted by applying an external force, the line joining the centre of gravity of the object and the centre of the earth must fall within the base of the object.

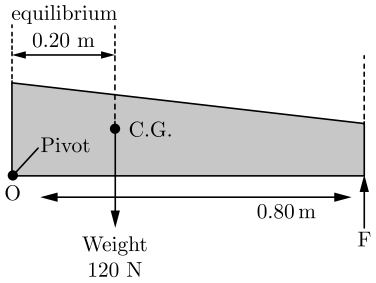
(b) Conditions for an object to be in unstable equilibrium:
  (i) Base of the object should be small.
  (ii) Top of the object should be heavy, i.e. it will raise its centre of gravity.
  (iii) When the object is slightly tilted by applying an external force, the line joining the centre of gravity of the object and the centre of the earth must fall outside the base of the object.

(c) Conditions for an object to be in neutral equilibrium:
  (i) On application of external force, the centre of gravity of the object should remain the same.
  (ii) When the external force is applied, the line joining the centre of gravity and centre of earth must fall within the base of the object.

NODIA
FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

NUMERICAL QUESTION

161. A non uniform beam of weight 120 N pivoted at one end is shown in the diagram below.



Calculate the value of F to keep the beam in equilibrium

Ans : MAIN 2024

The weight of the beam will produce a clockwise moment and the applied force F will produce a clockwise moment.

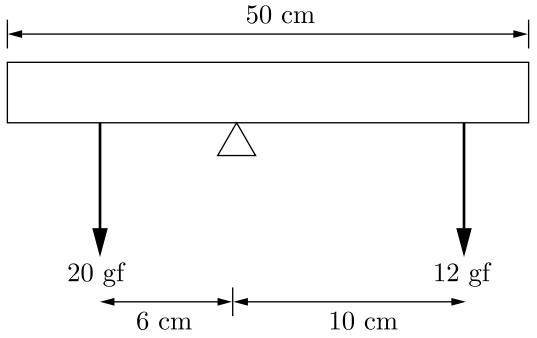
Equating the moments of the force,

$$120 \times 0.2 = F \times 0.8$$

$$F = \frac{120 \times 0.2}{0.8}$$

$$= 30 \text{ N}$$

162. A half metre rod is pivoted at the centre with two weights of 20 gf and 12 gf suspended at a perpendicular distance of 6 cm and 10 cm from the pivot respectively as shown below:



(i) Which of the two forces acting on the rigid rod causes clockwise moment ?

(ii) Is the rod in equilibrium ?

(iii) The direction of 20 kgf force is reversed. What is the magnitude of the resultant moment of the forces on the rod ?

Ans : COMP 2018

(i) 12 gf

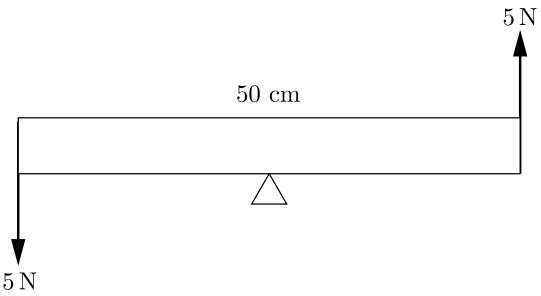
(ii) Yes,Because clockwise moment is equal to the anticlockwise moment.

(iii) If the direction of 20 gf force is reversed, it will also create a clockwise moment.

Resultant moment

$$120 + 120 = 240 \text{ dyne-cm(Clockwise)}$$

163. Two forces each of 5 N act vertically upwards and downwards respectively on the two ends of a uniform metre rule which is placed at its mid-point as shown in the diagram. Determine the magnitude of the resultant moment of these forces about the mid-point.

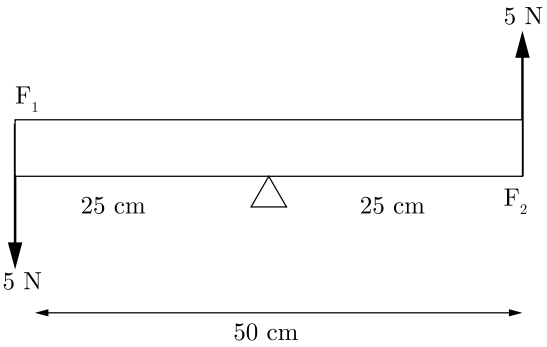


Ans : COMP 2014

According to the question,

Moment of force $F_1 = 5 \times 25 = 125$

Moment of force $F_2 = 5 \times 25 = 125$



Since both the forces are acting in anticlockwise direction, the resultant moment of force is the sum of the two moments.

Resultant moment of force $= 125 + 125$

$= 250$ N-m

164. A nut is opened by a wrench of length 20 cm. If the least force required is 2 N, find the moment of force needed to loosen the nut.

Ans : MAIN 2015

Length of wrench = 20cm = 0.2m

Force = 2N

Downloaded from www.pdf.tube

$$\text{Moment of force} = \text{Force} \times \text{length of arm}$$
$$= 2 \times 0.2 = 0.4 \text{ N m}$$

165. A boy weighs 360 N on the earth.
(a) What would be his approximate weight on the moon?
(b) What is the reason for your answer?

Ans : COMP 2010

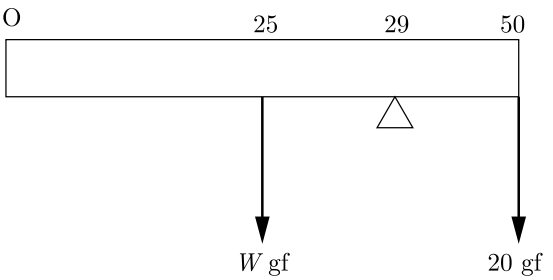
(a) Weight of the boy on the moon
$$= \frac{1}{6}\text{th of the weight of a boy on the earth}$$
$$= \frac{1}{6} \times 360 \text{ N} = 60 \text{ N}$$

(b) Value of acceleration due to gravity on the moon is one sixth of the acceleration due to gravity on the earth, i.e.
$$g_{moon} = \frac{1}{6} \times g_{\text{earth}}$$

166. A uniform half metre rule balances horizontally on a knife-edge at 29 cm mark when a weight of 20 gf is suspended from one end.
(i) Draw a diagram of the arrangement.
(ii) What is the weight of the half metre rule?

Ans : SQP 2017

Let the weight of the half metre scale be W.
To balance the half metre scale at 29 cm mark, the 20 gf weight should be suspended from the 50 cm end as shown in figure.



Moments due to W in anticlockwise direction
$$= W \times 4 \text{ cm}$$
Moments due to 20 gf in clockwise direction
$$= 20 \times 21 \text{ cm}$$
By the principle of moments, we have
$$W \times 4 = 20 \times 21$$
$$W = \frac{20 \times 21}{4} = 105 \text{ gf}$$

167. A boy of mass 30 kg is sitting at a distance of 2 m from the middle of a see-saw. Where should a boy of mass 40 kg sit so as to balance the see-saw?

Ans : COMP 2012

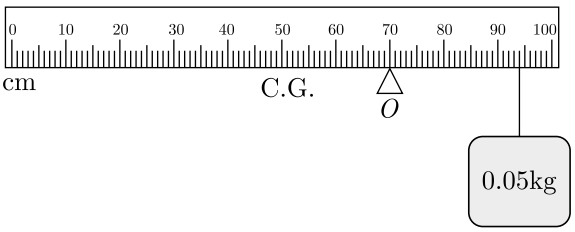
Let 40 kg boy sits at a distance of x m from the middle of a see saw.
According to the principle of moment

Anticlockwise moment = Clockwise moment
$$30 \times 2 \text{ m} = 40 \times x$$
$$x = 1.5 \text{ m}$$

168. A uniform metre scale can be balanced at the 70.0 cm mark when a mass of 0.05 kg is hung from the 94.0 cm mark. Draw a diagram of the arrangement and find the mass of the metre scale.

Ans : SQP 2011

Let m is the mass of the metre scale.



Anticlockwise moment about O
$$= \text{Clockwise moment about } O$$
$$m \times g \times (0.70 - 0.50) = 0.05 \times \text{g} \times (0.94 - 0.70)$$
$$m = \frac{0.05 \times 0.24}{0.20}$$
$$= 0.06 \text{ kg}$$

169. A man can open a nut by applying a force of 150 N by using a lever handle of length 0.4 m. What should be the length of the handle if he is able to open it by applying a force of 60 N?

Ans : MAIN 2011

Given, $F_1 = 150 \text{ N}$, $d_1 = 0.4 \text{ m}$;
$F_2 = 60 \text{ N}$

NODIA

$$F_1 \times d_1 = F_2 \times d_2$$
$$15 \times 0.4 = 60 \times d_2$$
$$d_2 = 1.0\,\text{m}$$

170. A force of 2.5 N with its arm 0.5 m long rotates a spanner in clockwise direction. Find the torque.

Ans : MAIN 2011

$$\text{Force, } F = 2.5\,\text{N}$$
$$\text{Force arm} = 0.5\,\text{m}$$
$$\text{Torque, } (\tau) = \text{Force } (F) \times \text{Force arm } (d)$$
$$= 2.5 \times 0.5$$
$$= 1.25 \text{ N m}$$

171. The moment of a force of 12 N about a fixed point O is 6 Nm. Calculate the distance of the point O from the line of action of the force.

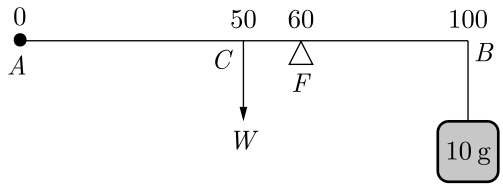
Ans : SQP 2017

$$\text{Force, } F = 12\,\text{N},$$
$$\text{Moment of force} = 6\,\text{Nm}$$
$$\text{Moment of force} = F \times r$$
$$6\text{ Nm} = 12\,\text{N} \times r$$
$$r = 0.5\,\text{m}$$

172. A uniform metre scale rests horizontally on a knife edge at the 60 cm mark when a mass of 10 g is suspended from one end. From which end this mass be suspended ? What is the mass of the metre scale ?

Ans : COMP 2020

It is clear from the figure, the weight W of the metre scale acts at the 50 cm mark. The mass of 10 g must be suspended from the other end i.e., from B.



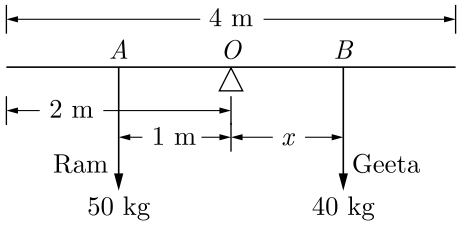
Since the metre scale is in equilibrium.
According to the principle of moments,

$$W \times (60 - 50) = 10 \times (100 - 60)$$
$$W \times 10 = 10 \times 40$$
$$W = 40\,\text{g}$$

173. A uniform see-saw 4 m long is supported at its centre, Ram weighing 50 kg sits 1 m from the centre of see-saw, where should Geeta weighing 40 kg sit on the other side of the see-saw so as to balance it horizontally?

Ans : SQP 2023

Let Geeta sit at point B at a distance x from the centre of the see-saw as shown in the figure.

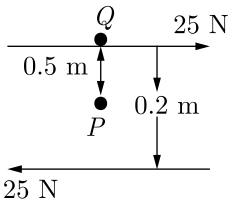


Taking moments of all forces about the point O and using the principle of moment. We get
Anticlockwise moment about O = Clockwise moment about O

$$50 \times 1 = 40 \times x$$
$$x = \frac{50 \times 1}{40} = 1.25\text{cm}$$

Geeta should sit 1.25 m from the centre to balance the see-saw horizontally.

174. From the given figure, calculate moment of force about (a) P and (b) Q.



Ans : COMP 2000

(a) Moment of right directed force about,

$$P = 25 \times 0.05 = 1.25 \text{ N-m (clockwise)}$$

Moment of left directed force about,

$$P = 25 \times 0.15 = 3.75 \text{ N-m (clockwise)}$$

Since both the moments are clockwise hence total moment about

$$P = 1.25 + 3.75$$
$$= 5.00 \text{ N-m (clockwise)}$$

(b) Moment of right directed force about,

$$Q = 25 \times 0 = 0$$

Moment of left directed force about,

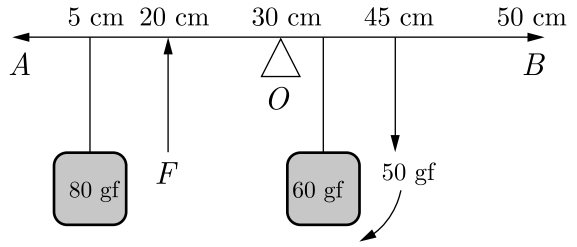
$$Q = 25 \times 0.20 = 5.00 \text{ N-m (clockwise)}$$

Click Here to Buy book on Amazon

Total moment about, Q

$= 0 + 5.00$ N m $= 5.00$ N-m (clockwise).

175. A uniform metre scale of weight 50 g f is balanced at 30 cm mark when weights of 80 g f and 60 g f act at 5 cm mark and 45 cm mark respectively. What force must be applied at 20 cm mark to balance the metre scale?



Ans : MAIN 2017

If we take moment about 30 cm mark

Anticlockwise moment

$= 80 \times 25 = 2000$ gf cm

Clockwise moment $= 60 \times 15 + 50 \times 20$

$= 1900$ gf cm

Here anticlockwise moment $>$ clockwise moment. Therefore, force at 20 cm mark must act in upward direction to keep the scale in equilibrium.

Now taking moments about 30 cm mark

Sum of anticlockwise moments = Sum of clockwise moments

i.e., $80 \times 25 = 60 \times 15 + F \times 10 + 50 \times 20$

$2000 = 1900 + F \times 10$

$F = \frac{100}{10} = 10$ gf

Resultant moment of force about the mid-point of rod

$=$ Moment of force (at A about O + at B about O)

$= F \times OA + F \times OB$

$= F \times (OA + OB)$

$= F \times AB$

$= 2 \times 1 = 2$ N - m (Clockwise)

176. A scooter mechanic can open a nut by applying 120 N force while using a lever of 50 cm in length. How long handle is required if he wishes to open it by applying a force of only 40 N?

Ans : SQP 2007

Force, $F = 120$ N

Length of lever $= 50$ cm $= 0.5$ m

In first case,

Moment of force $= 120$ N $\times 0.5$ m

$= 60$ N m

In second case,

If he uses handle of length l m, then

Moment of force $= 40$ N $\times\ l$ m

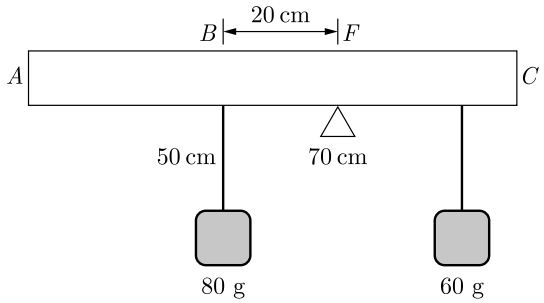
$60 = 40 \times l$

$l = \frac{60 \text{ N m}}{40 \text{ N}} = 1.5$ m

177. A uniform metre scale of mass 80 g is to be balanced at the 70 cm mark. Find, from where must a mass of 60 g be suspended to do so.

Ans : COMP 2006

Since the metre rod is balanced about F, the algebraic sum of the moments about the point F, must be zero. Let 60 g be suspended at x cm from the zero end at A.



$80 \times 20 = 60 \times (x - 70)$

$x - 70 = \frac{80 \times 20}{60}$

$= 26.67$

$x = 26.67 + 70$

$x = 96.67$ cm

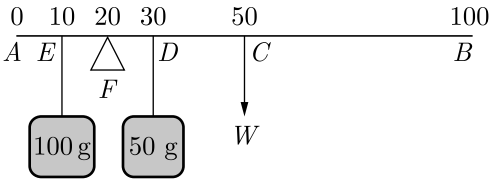
178. A uniform metre scale is balanced at the 20 cm mark when masses of 100 g and 50 g are suspended from the 10 cm and 30 cm marks respectively. Calculate the mass of the metre scale.

Ans : COMP 2005

The various positions where the weights are acting as shown in the figure. AB is the metre scale of mass W.

FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

Downloaded from www.pdf.tube



Since the metre scale balances about the point F , sum of the clockwise moments must be equal to the sum of the anticlockwise moments.
Taking moments about E, we get

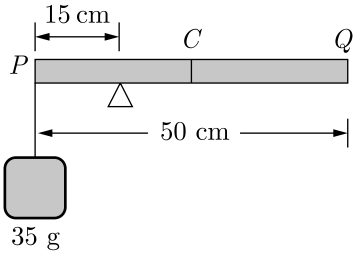
$$100 \times EF = 50 \times DF + W \times CF$$

$$100 \times 10 = 50 \times 10 + W \times 30$$

$$W \times 30 = 500$$

$$W = \frac{500}{30} = 16.67 \text{ g}$$

179. In the given diagram a uniform half metre scale PQ is balanced horizontally across a knife edge. Calculate (a) the mass of the scale, (b) the force on the knife-edge, (c) state the direction in which the force on the knife-edge, acts.



Ans : COMP 2023

(a) Let the mass of the scale be x g acting at centre C of the scale PQ.
Taking the moments about the knife-edge we get
Clockwise moment = Anticlockwise moment

$$x \times 10 = 35 \times 15$$

$$x = \frac{35 \times 15}{10}$$

$$= \frac{525}{10} = 52.5 \text{ g}$$

(b) The force on the knife-edge

$$= 35\text{g f} + 52.5 \text{ g f}$$

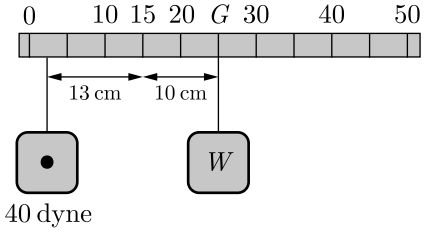
$$= 87.5\text{g f}$$

(c) The force of 87.5 gf will act in the downward direction.

180. A 50 cm uniform ruler is freely pivoted at 15 cm mark which balances horizontally when an object of weight 40 dyne is hung from the 2 cm mark. Draw a force diagram of the arrangement and calculate the weight of the ruler. Also calculate the force with which pivot is pressed.

Ans : SQP 2021

As per the question we can draw the following figure,



The figure shows the arrangement of forces.
From the principle of moment,
Anticlockwise moment = Clockwise moment

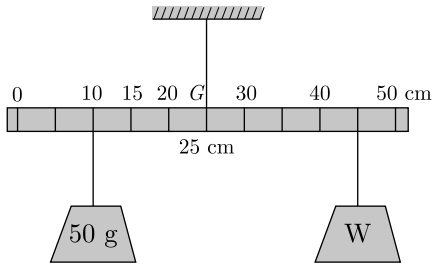
$$w \times 10 = 40 \times 13$$

$$w = \frac{40 \times 13}{10} = 52$$

Force with which the pivot is pressed

$$= 50 + 40 = 92 \text{ dyne}$$

181. A half metre ruler is suspended by a thread from the mid-point of the ruler as shown in the figure.



It balances horizontally when a 50 g and an unknown weight w are suspended respectively from 10 cm and the 45 cm mark. Calculate the magnitude of weight w.

Ans : SQP 2018

Since the ruler is in equilibrium.
According to the principle of moment,

Clockwise moment = Anticlockwise moment

$$W \times 20 = 50 \times 15$$

$$\text{w} = \frac{50 \times 15}{20}$$

$$= 37.5 \text{ g f}$$

182. A uniform metre scale balances horizontally on a knife-edge placed at 55 cm mark when a mass of

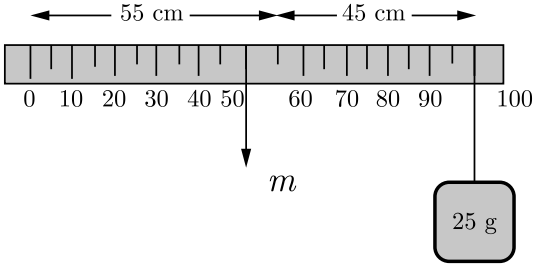
NODIA

25 g is suspended from one end. Draw a diagram of this arrangement. Calculate the mass of the scale.

Ans : MAIN 2022

Let the mass of the metre scale is m.
As metre scale is uniform, therefore, its weight acts at 50 cm mark.
Taking moment about 55 cm mark

Anticlockwise moment = Clockwise moment



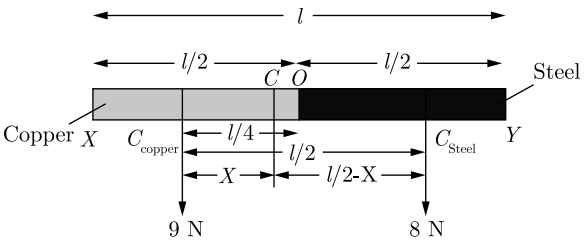
$$m \times 5 = 25 \times 45$$

$$m = \frac{25 \times 45}{5} = 225 \text{ g f}$$

Mass of the metre scale is 225 g f.

183. In a metre rod half of it is made of copper and rest half of steel. Weights of copper and steel are 9 N and 8 N respectively. Is the centre of gravity of the rod at its geometric centre? If not, where is it?

Ans : COMP 2015



As the rod is not uniform, half portion of the rod, made up of copper is heavier. Therefore, its centre of gravity is not at the geometrical centre.
Let the rod XY be of length l. Let C_{copper} and C_{steel} be the centre of gravity of Copper the copper and steel parts respectively. If C is the centre of the gravity of the combination, then by taking moment about C.

$$9 \times x = 8 \times \left(\frac{l}{2} - x\right)$$

$$9x = 8 \times \frac{l}{2} - 8x$$

$$17x = 4l \Rightarrow x = \frac{4}{17}l$$

$$OC = \frac{l}{4} - \frac{4}{17}l = \frac{1}{68}l$$

Hence the centre of gravity of the combined rod is at point C at a distance of $\frac{1}{68}l$ from the geometrical centre O of the rod towards the copper half of the rod.

184. The iron gate of a building is 3 m broad. It can be opened by applying 100 N force at the middle of the gate. Calculate the least force required to open this gate. Where should the force be applied?

Ans : COMP 2007

Moment of force required to open the gate

$$= F \times d_{\perp}$$

$$= 100 \times 1.5$$

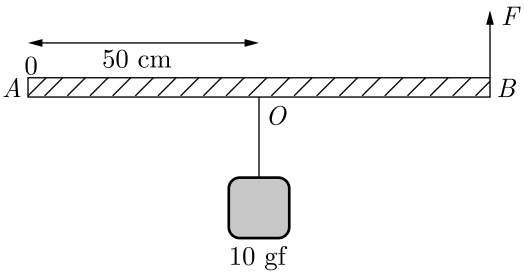
$$= 150 \text{ N-m}$$

For the least force required to open the gate, it is to be applied at the farthest point from the hinges i.e., it should be applied at the free end of the gate.
Let the force required is F.

Then, $F \times 3 \text{ m} = 150 \text{ N-m}$

$$F = \frac{150 \text{ N m}}{3 \text{ m}} = 50 \text{ N}$$

185. A uniform metre rule of weight 10 gf is pivoted at its O mark.
(i) What moments of the force depress the rule ?
(ii) How can it be made horizontal by applying a least force ?



Ans : MAIN 2012

(i) The moments of the weight of the metre rule about 0 cm mark $= 10 \times 50 = 500$ gf cm i.e., clockwise.
(ii) To make it horizontal by applying the least force, the force must be applied at the farthest point, i.e., at B. Let F be the force applied upwards.
Then taking moments about 0 cm mark

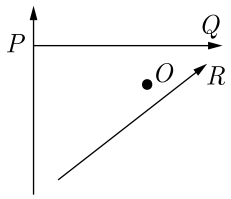
$$F \times 100 = 50 \times 10$$

Click Here to Buy book on Amazon

$$F = 5 \text{ gf}$$

A minimum force of 5 gf must be applied at B in the upward direction.

186. P, Q and R are three coplanar forces which act as shown in the figure.



A point O lies in the same plane, $P = Q = R = 6$ N.

(i) Which force has the least moment about O?

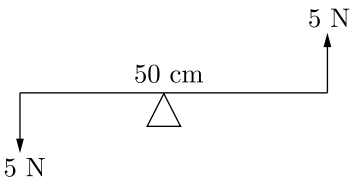
(ii) Which force has the greatest moment about O? Give a reason.

Ans : COMP 2021

(i) Force R has the least moment about O because it is nearest to the point O.

(ii) Force P has the greatest moment about O because it is farthest from the point O.

187. Two forces each of 5 N act vertically upwards and downwards respectively on the two ends of a uniform metre rule which is placed at its mid-point as shown in the diagram. Determine the magnitude of the resultant moment of these forces about the mid-point.



Ans : SQP 2009

Resultant moment of force about the mid-point

Moment of couple = Force × Perpendicular distance between the forces.

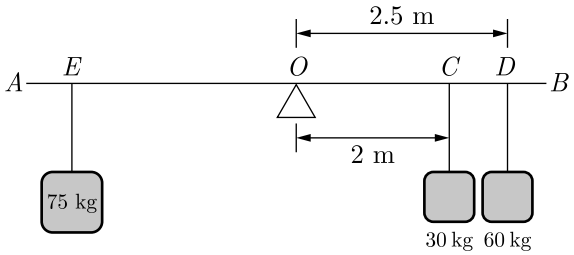
$= 5 \times (0.5 + 0.5)$ m

$= 5$ Nm (anticlockwise)

188. On a see-saw, two children of masses 30 kg and 60 kg are sitting on one side of it at distances 2 m and 2.5 m respectively from the centre of the see-saw. Find the distance at which a man of mass 75 kg should sit on the other side to balance the see-saw.

Ans : COMP 2011

Let AB be the see-saw. Children are located at C (30 kg) and D (60 kg). Let E be the point where the mass of 75 kg is located. In the balanced position of the see-saw, the sum of the clockwise moments be equal to the sum of the anticlockwise moments.



Taking moments about O :

$$60 \times 2.5 + 30 \times 2 = 75 \times OE$$

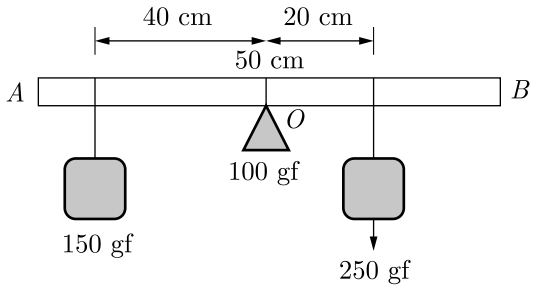
$$75 \times OE = 150 + 60$$

$$OE = \frac{210}{75} = 2.8 \text{ m}$$

189. A uniform metre rule weighing 100 gf pivoted at its centre O. Two weights 150 gf and 250 gf hang from the metre rod as shown. Calculate (i) the total anticlockwise moments about O, (ii) the total clockwise moments about O, (iii) the difference of anticlockwise and clockwise moments about O and (iv) the distance from O where a 100 gf weight should be placed to balanced the metre rule.

Ans : SQP 2010

The diagram of the arrangement of the weights is as shown in the figure.



(i) The moments of the weight of 150 gf

$= 150 \text{ gf} \times 40 \text{ cm}$

$= 6000$ gfcm

(ii) The moments of the weight of 250 gf

$= -250 \times 20$

$= -5000$ gfcm, i.e., clockwise

(iii) The difference of moments

NODIA

$$= 6000 \text{ gf cm} - 5000 \text{ gf cm}$$

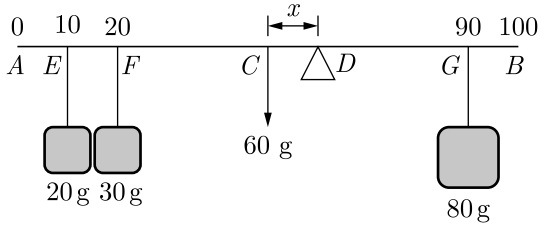
$$= 1000 \text{ gfcm}$$

(iv) To balance these 1000 gf cm anticlockwise moments, 100 gf weight must be at a distance $x = \dfrac{1000 \text{ gfcm}}{10 \text{ gf}} = 10 \text{ cm}$ on the right side of O.

190. A uniform metre scale of mass 60 g, carries masses of 20 g, 30 g and 80 g from points 10 cm, 20 cm and 90 cm marks. Where must the knife edge be placed to balance the scale?

Ans : MAIN 2008

Let D be the position of the knife edge so that the metre scale and the various masses are balanced. Since the metre scale is balanced. Sum of the clockwise moments must be equal to the sum of the anticlockwise moments.



Taking moments about D, we get

$$80 \times GD = 20 \times ED + 30 \times FD + 60 \times CD$$

$$80 \times (40 - x)$$

$$= 20 \times (40 + x) + 30 \times (30 + x) + 60x$$

$$3200 - 80x = 800 + 20x + 900 + 30x + 60x$$

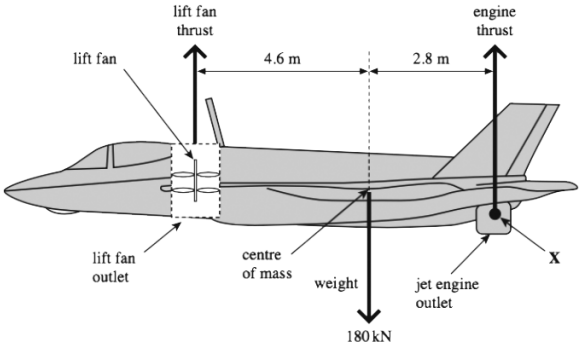
$$1500 = 190x$$

$$x = \frac{1500}{190} = 7.9 \text{ cm}$$

Position of the mark on the metre rod where the knife edge should be placed is $50 + 7.9 = 57.9$ cm.

CASE BASED QUESTION

191. Figure shows an aircraft designed to take off and land vertically and also to hover without horizontal movement. In order to achieve this, upward lift is produced by directing the jet engine outlet downwards. The engine also drives a vertical lift fan near the front of the aircraft. The weight of the aircraft is 180 kN. The distance between the lift fan and the centre of mass is 4.6 m and the distance between the jet engine outlet and the centre of mass is 2.8 m.



(i) Calculate the moment caused by the weight of the aircraft about the point X.

(ii) By taking moments about X, calculate the lift fan thrust if the aircraft is to remain horizontal when hovering.

(iii) Calculate the engine thrust in Figure.

Ans :

(i) The moment caused by the weight of the aircraft about the point X

$$180000 \times 2.8 = 504000 \text{ Nm}$$

(ii) According to the principle of moment

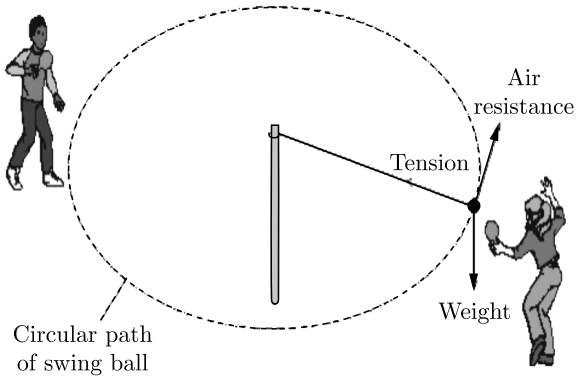
$$7.4 \times \text{lift fan thrust}(F) = 180000 \times 2.8$$

$$F = 68108 \text{ Nm}$$

(iii) $$\text{Engine thrust} = 180000 - 68108$$

$$= 111892 \text{ N}$$

192. The diagram shows two children playing with a toy called a swing ball. The ball is joined to a pole by a strong string. The children hit the ball so that it goes round in a circular path.



(i) Which force causes the ball to move in a circle?

(ii) Complete the sentences by writing the correct words.

(a) The force needed to make the ball move in a circular path is larger if the speed of the ball is ..... (Increased/Decreased).

Downloaded from www.pdf.tube

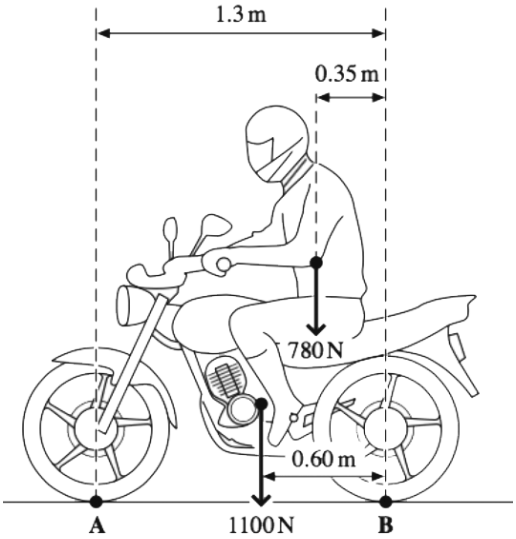
(b) The continuous acceleration of a ball moving in a circular path changes the ..... of the ball.(Speed, Direction).

(iii) Which of the following words is used to describe any force that causes an object to move in a circular path?
Centripetal, Frictional, Gravitational

Ans :

(i) Tension
(ii) (a) increased
(b) direction
(iii) Centripetal

193. Figure shows a motorcycle and rider. The motorcycle is in contact with the road at A and B.



The motorcycle has a weight of 1100 N and the rider's weight is 780 N.

(i) State the Principle of Moments.
(ii) Calculate the moment of the rider's weight about B. Give appropriate unit.
(iii) By taking the moments about B, calculate the vertical force that the road exerts on the front tyre at A. State your answer to an appropriate number of significant figures.

Ans :

(i) According to the principle of moments, the sum of anticlockwise moments of forces about any point must be equal to the sum of clockwise moments of the forces about the same point.
(ii) Moment of rider's weight about B

$$= 780 \times 0.35 = 270 \text{ Nm}$$

(iii) According to the principle of moment

$$1 + (1100 \times 0.60) = F_A \times 1.3$$

$$= \frac{933}{1.3} = 720 \text{ N}$$

194. Figure 1 is a diagram of a human arm lifting an object.

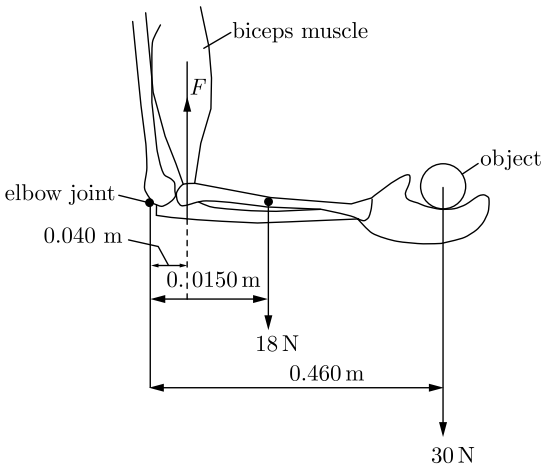


Figure 1

The lower arm is horizontal and its centre of gravity is 0.150 m from the elbow joint. The weight of the lower arm is 18 N. The biceps muscle exerts a vertical force F on the arm. The horizontal distance between the elbow joint and the point of attachment of the muscle to the lower arm bone is 0.040 m. The weight of the object held in the hand is 30 N and its centre of gravity is 0.460 m from the elbow joint. The arm is in equilibrium.

(i) Define centre of gravity.
(ii) Calculate the total clockwise moment about the elbow joint.
(iii) As the lower arm is moved away from the body, the force F exerted by the biceps muscles acts an angle θ to the vertical as shown in Figure 2.

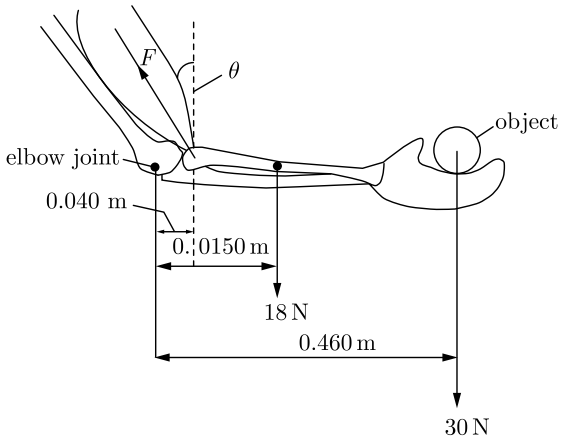


Figure 2

NODIA

Describe and explain what happens to each of the following quantities as the angle θ is increased

1. The anticlockwise moment about the elbow joint.
2. The magnitude of the force F.

Ans :

(i) The centre of gravity is a point in an object where the distribution of weight is equal in all directions, and it does depend on the gravitational field.

(ii)

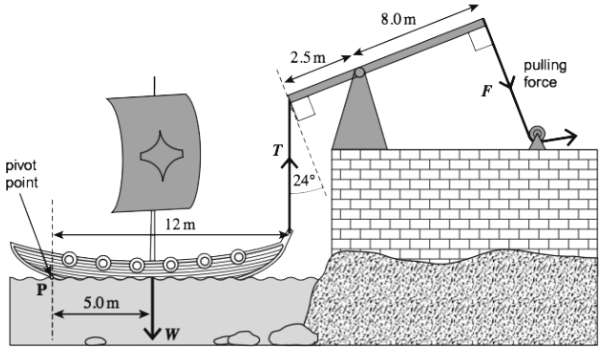
$$\text{Clockwise Moment} = (0.150\times18)+(0.460\times30)$$
$$= 2.25 + 13.8$$
$$= 16.05 \text{ Nm}$$

(iii) 1. The clockwise moment is equal to the anticlockwise moment i.e. 16.05 Nm

2. $F\cos\theta = 412.5$ or $F \propto \dfrac{1}{\cos\theta}$

Hence the force increases.

195. It is said that Archimedes used huge levers to sink Roman ships Invading the city of Syracuse. A possible system is shown in Figure. Where a rope is hooked on to the front of the ship and the lever is pulled by several men.



(i) Calculate the mass of the ship if its weight was 3.4×10^4 N.

(ii) Calculate the moment of the ship's weight about point P. State an appropriate unit for your answer.

(iii) Calculate the minimum vertical force, T, required to start to raise the front of the ship. Assume the ship pivots about point P.

Ans :

(i)
$$w = mg$$
$$m = \frac{w}{g} = \frac{3.4\times10^4}{9.81}$$
$$= 3465 \approx 3500$$

(ii) Moment of ship is weight about point P
$$= 34000 \times 5.0$$
$$= 1.7 \times 10^5 \text{ Nm}$$

(iii)
$$170000 = T \times 12$$
$$T = \frac{170000}{12}$$
$$= 14166.66 \text{ N}$$
$$= 1.4 \times 10^4 \text{ N}$$

196. The hammer throw is an athletic event. The athlete throws a heavy metal ball attached by a wire to a handle.

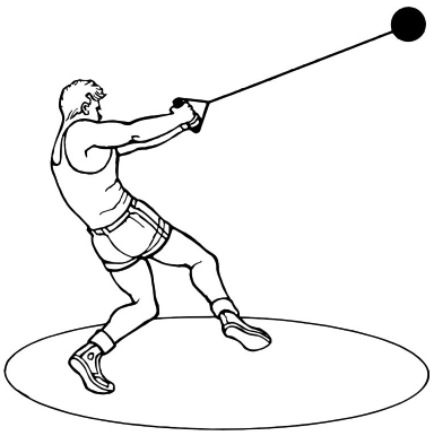


Figure 1

The hammer thrower swings the hammer round in a circle before letting go. He swings the hammer slowly at first and then faster.

The Figure 2 shows an overhead view of a hammer thrower swinging the hammer anticlockwise in a circle.

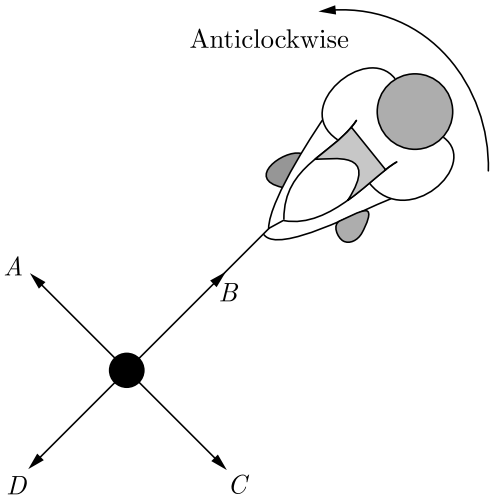


Figure 2

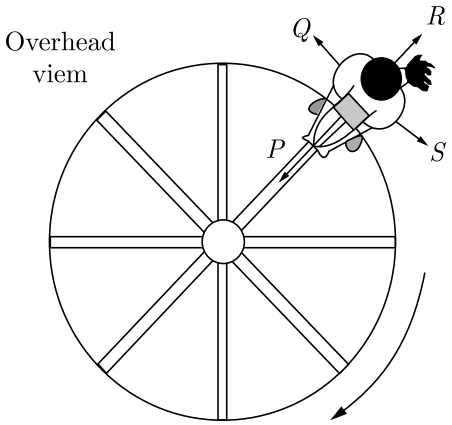
Click Here to Buy book on Amazon

(i) In which direction, A, B, C or D does the centripetal force act on the hammer?
(ii) Complete the following sentence by correct word
The centripetal force is provided by the ..... (Tension in the wire/stress in the wire)
(iii) At the instant shown in the diagram above, the athlete lets go of the handle. In which direction, A, B, C or D, does the hammer move?

Ans :

(i) B
(ii) Tension in the wire
(iii) C

197. A girl and her father visit a children's playground. The diagram shows the girl holding on to a round about which is turning.

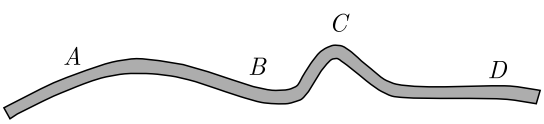


A centripetal force must act because the girl moves in a circular path.
(i) In which direction P, Q, R or S, does the centripetal force act?
(ii) What provides this centripetal force?

Ans :

(i) P
(ii) The tension in the child's arms provides this centripetal force.

198. The diagram shows part of a level road that they take when they drive home. They drive at a steady speed.

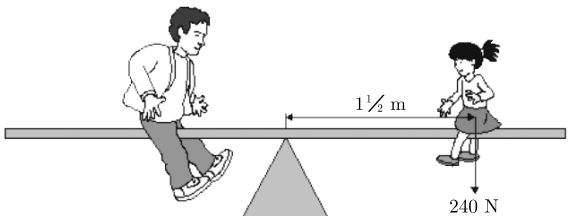


(i) At which point, A, B, C or D, will the centripetal force on the car be greatest?
(ii) What provides the centripetal force when the car goes round a bend?

Ans :

(i) C
(ii) friction

199. A young girl and her father go to a playground. The diagram depicts the girl and her father on a see-saw.

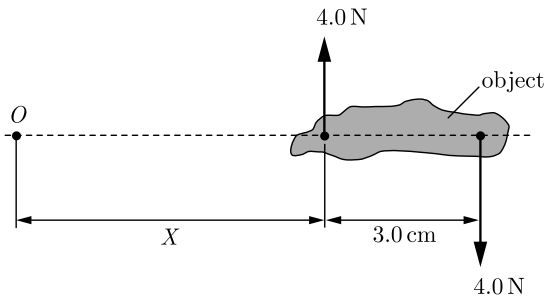


Based on the given diagram, answer the following questions.
(i) Calculate the moment of the girl ?
(ii) What must her father do to increase his moment?

Ans :

(i) Force = 240 N
Perpendicular distance from axis = 1.5 m
Moment = Force × perpendicular distance from axis
= 240 × 1.5 = 360 Nm
(ii) move towards the left.

200. Figure shows two equal but opposite forces acting on an object.



The point O is at a distance x from the nearer of the two forces.
(i) The separation between the two forces is 3.0 cm. Determine the torque of the couple exerted on the object.
(ii) Calculate the total moment of the forces the point O and state the significance of this value.

Ans :

NODIA

(i) Torque (τ) = Force (F) × Lever arm $(d_\perp)$

$= 4.0 \times 0.03$

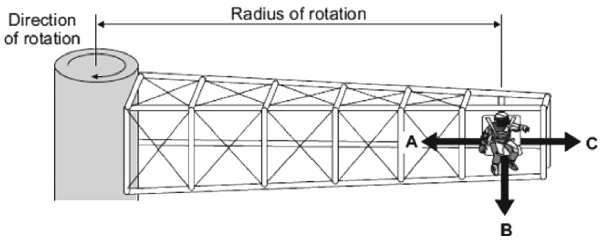
torque $= 0.12\,(\text{Nm})$

(ii) Total moment $= (x + 0.03) \times 4.0 - 4.0x$

$= 4.0x + 0.12 - 4.0x$

Total moment $= 0.12$ Nm

201. The diagram shows a 'G-machine'. The G-machine is used in astronaut training.

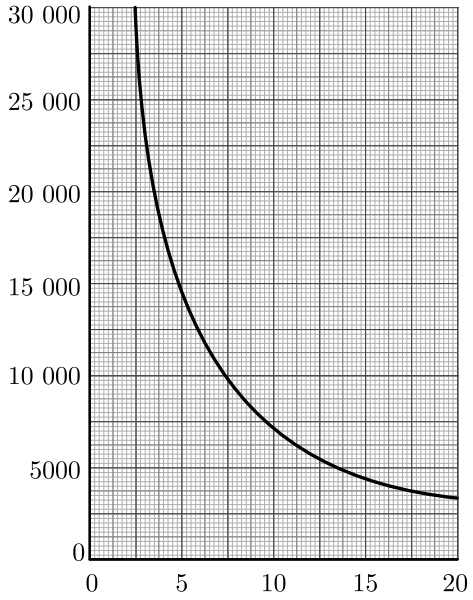


The G-machine moves the astronaut in a horizontal circle.

(i) In which direction, A, B or C does the centripetal force on the astronaut act?

(ii) Complete the following sentence to give the conclusion that can be made from Graph X. Increasing the speed of rotation of a G-machine will ..... the centripetal force on the astronaut. (increase/decrease).

(iii) Graph Y shows how the centripetal force is affected by the radius of rotation, when the speed of rotation is kept the same.



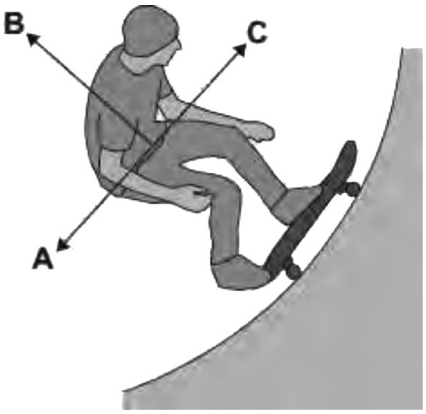
Radius of rotation in metres

Complete the following sentence to give the conclusion that can be made from Graph Y. The greater the radius of rotation, the ..... the centripetal force on the astronaut. (smaller/less).

Ans :

(i) A
(ii) increase
(iii) smaller

202. The drawing shows a skateboarder moving in a circular path as shown in the figure



Centre of circular path

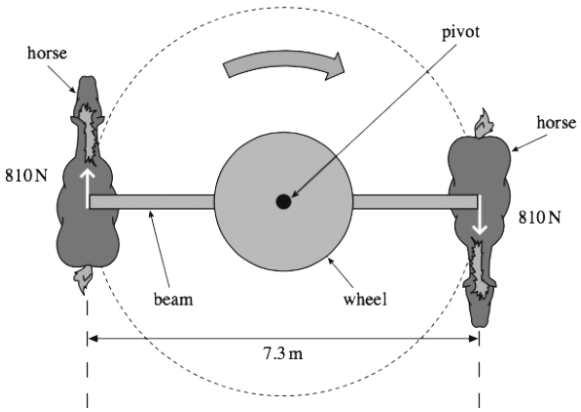
(i) What is the name of the resultant force which allows the skateboarder to move in a circular path?

(ii) In which direction A, B or C does this resultant force act on the skateboarder?

Ans :

(i) Centripetal force
(ii) B

203. Horses were once used to power machinery in factories, mines and mills. Figure shows two horses attached to a beam which turns a wheel. This wheel drives machinery.



NODIA

Each horse exerts a force of 810 N and the length of the beam is 7.3 m.

(i) Define the moment of a couple.

(ii) Calculate the moment of the couple exerted by the horses, stating an appropriate unit.

Ans :

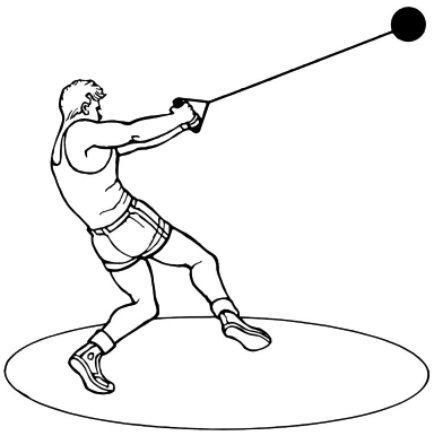
(i) The moment of a couple is defined as the product of either of the forces of a couple and the perpendicular distance between the line of action of forces.

(ii) Moment of the couple exerted by the horses

$= 810 \times 7.3$

$= 5913$ Nm

204. The hammer throw is an athletic event. The athlete throws a heavy metal ball attached by a wire to a handle.

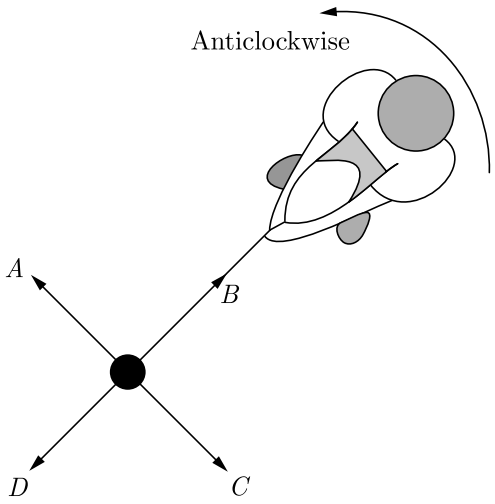


The hammer thrower swings the hammer round in a circle before letting go. He swings the hammer slowly at first and then faster.

(i) Complete the following sentence by correct word.

As the speed of the swing increases, the centripetal force on the hammer ..... (increases/decreases).

(ii) The diagram shows an overhead view of a hammer thrower swinging the hammer anticlockwise in a circle.



(a) In which direction, A, B, C or D, does the centripetal force act on the hammer?

(b) At the instant shown in the diagram above, the athlete lets go of the handle. In which direction, A, B, C or D does the hammer move?

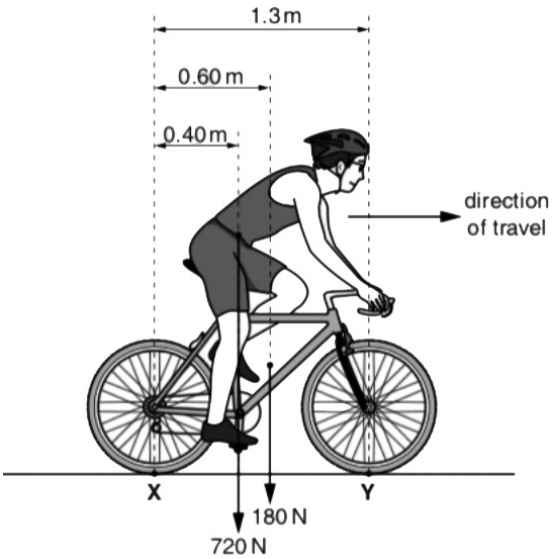
Ans :

(i) increases

(ii) (a) B

(b) C

205. Figure shows a cyclist.



The bicycle tyres are in contact with the road at X and Y. The cyclist is travelling at constant velocity on a level road. The weight of the bicycle is 180 N and the weight of the cyclist is 720 N.

(i) State the magnitude of the resultant force acting on the cyclist. Explain your answer.

NO NEED TO PURCHASE SAMPLE PAPERS
Download India's Best 20 Sample Papers
DOWNLOAD NODIA APP
Every School conduct Pre-Board
From These Sample Papers

Downloaded from www.pdf.tube

(ii) Define moment of a force.
(ii) Explain why the two vertical forces acting on the tyres at X and Y do not form a couple.
(iv) Take moments about X to determine the size of the vertical force F acting on the type at Y.
(v) The cyclist leans further forward. How does this affect the force on the type at X?

Ans :

(i) There is no acceleration therefore the resultant force is zero.
(ii) The turning effect of force is known as moment of force. It is the product of the force multiplied by the perpendicular distance from the line of action of the force to the pivot or point where the object will turn.
(iii) Forces are in the same direction.
(iv) Clockwise moments

$$= (720 \times 0.40) + (180 \times 0.60)$$

$$= 288 + 108$$

$$= 396 \text{ (N m)}$$

sum of clockwise moments = sum of anticlockwise moments

$$396 = 1.3\,F$$

$$F = 300\,(N)$$

(v) The force at X decreases

www.nodia.in

NODIA

CHAPTER 2

WORK, POWER AND ENERGY

SUMMARY

1. WORK

Work is said to be done when the point of application of force moves in the direction of applied force. Work done on an object is equal to the product of the force and distance moved along the line of action of force,

i.e., $W = Fs$

If the direction of applied force is not in the direction of motion of the object, the work done is given by the expression

$$W = F\cos\theta \times s$$

$$= F \times s\cos\theta$$

Where, $F\cos\theta$ is the component of force along the direction of the displacement of the object. Work is a scalar quantity. The SI unit of work is joule (J). Thus, 1 joule of work is said to be done by a force of 1 newton when it displaces an object by 1 metre along the direction of force. Larger units of work are

$$1\text{ kJ} = 10^3\text{ J}$$

$$1\text{ MJ} = 10^6\text{ J}$$

The CGS unit of work is erg. Thus, 1 erg of work is said to be done by a force of 1 dyne when it displaces an object by 1 centimetre along the direction of force.

Relation between the joule and erg:

$$1\text{ joule, J} = 10^7\text{ erg}$$

2. POWER

Power is the measure of how fast or slow work is done. It is defined as the rate of doing work, *i.e.*

$$\text{Power}\,(P) = \frac{\text{Work done}\,(W)}{\text{Time taken}\,(t)}$$

Power is a scalar quantity. Its SI unit is joule/second and C.G.S unit is erg/second. In the honour of James Watt who developed steam engine, the SI unit of power is also called a watt (W), i.e.

$$1\text{ W} = 1\text{ J/s}$$

Relation between SI and CGS units of power is

$$1\text{ W} = 1\text{ J/s} = 10^7\text{ erg/s}$$

$$1\text{ kW} = 10^3\text{ W}$$

$$1\text{ MW} = 10^6\text{ W}\quad 1\text{ GW} = 10^9\text{ W}$$

The practical unit of power used in engineering is horse power.

$$1\text{ horse power (hp)} = 746\text{ watt}\ (W)$$

3. ENERGY

An object which is able to do work is said to possess energy. The capacity of an object to do work is called its energy. Energy is a scalar quantity. The SI unit of energy is joule (J) and its CGS unit is erg.

The larger units of energy are watt hour (W h) and kilowatt hour (kW h).

$$1\text{ W h} = 3600\text{ J}$$

$$1\text{ kW h} = 3.6 \times 10^6\text{ J}$$

Other units of energy are calories and eV.

$$1\text{ cal} = 4.18\text{ J}$$

$$1\text{ eV} = 1.6 \times 10^{-19}\text{ J}$$

4. DIFFERENT TYPES OF ENERGY

Energy is found in various forms such as mechanical energy, chemical energy, heat energy, elastic energy, sound energy, light energy, electrical energy, nuclear energy, etc.

4.1 Mechanical Energy

Mechanical energy is of two types, viz. kinetic energy and potential energy.

1. Kinetic Energy

Kinetic energy is the energy possessed by an object by virtue of its motion. Its expression is

$$\text{KE} = \frac{1}{2}mv^2$$

Where, m is the mass of the object and v, is the

Click Here to Buy book on Amazon

velocity attained by the object.

An object possessing horizontal or vertical motion posses kinetic energy. There are many forms of kinetic energy:

(i) Translational kinetic energy possessed by virtue of its motion from one location another, *e.g.* a train moving on a track, motion of a bullet fired from a gun.

(ii) Rotational kinetic energy is the kinetic energy due to rotation of an object around an axis and is part of its kinetic energy, *e.g.* blades of a rotating fan.

(iii) The vibrational kinetic energy is the kinetic energy due to vibrational motion of an object, *e.g.* cellphone that vibrates when it is ringing, vibration of a drum when it is hit by a hammer.

2. Potential Energy

Potential energy is the energy possessed by an object due to its position or configuration. Its expression is

$$\text{PE (or U)} = mgh$$

Where, m is the mass of the object, g is the acceleration due to gravity and h is the height through which the object is raised above the earth's surface. It is also known as gravitational potential energy as the work is done against gravity.

Transformation of energy is the conversion of energy from one form to the other.

4.2 Internal Energy

Internal energy is the energy contained in a body due to the motion of the molecules constituting, it. As molecules vibrate with respect to one another, these will be both kinetic energy of motion and the potential energy due to mutual attractions and repulsions. Interval energy is the totality of this energy with the increase in internal energy of the body, the temperature of the body goes up. On rubbing our hands against each other kinetic energy in our hands is converted into internal energy by friction.

4.3 Electrical Energy

Electric charges and currents attract or repel each other that is they exert forces on each other. Here the work is required to be done to move the free charge carriers with respect to each other in a particular direction through a conductor. The energy associated with this work is called electrical energy or electromagnetic energy.

NODIA

4.4 Chemical Energy

Chemical energy of a body say a chemical compound is the energy possessed by it by virtue of chemical bonding of its atoms. A stable chemical compound has less energy than its separated parts. This difference is due to specific arrangement and motion of electrons and nuclear in the compound which is called chemical energy or energy of chemical binding. The chemical energy available in a chemical reaction may be depending on whether the total energy of the reactants is less or more than that of the products, i.e. endothermic or exothermic reaction.

4.5 Nuclear Energy

Protons and neutrons attract each other at distances of the order of 10^{-15} m and bind to form nuclei. This associated energy is called nuclear energy. This energy can be obtained by nuclear fission and nuclear fusion.

Nuclear fission involves splitting of a less stable heavy nucleus such as $^{235}_{92}\text{U}$ into two or more stable nuclei and some neutrons, *e.g.* nuclear energy production in nuclear reactor. Nuclear fusion involves fusion of two or more lighter nuclei to form a heavy nucleus, *e.g.*energy production in sun and stars. In both the cases, a certain mass disappears which appears in the form of nuclear energy.

4.6 Sound Energy

Sound is a form of mechanical vibration which produces a sensation of hearing in our ears by propagating through any mechanical medium. These vibrations are collected by the outer human ear, strike on the ear drum, which transmits sound into the inner ear.

4.7 Light Energy

Light is a form of electromagnetic energy. Each colour of light represents a different amount of electromagnetic energy. Electro magnetic energy is also carried by radio waves, X-rays and laser light.

4.8 Heat Energy

Heat Energy is the result of the random motion of the molecules and to their mutual potential energy that is to internal energy. Heat energy can be transferred from one object to another and the transfer or flow due to difference in temperature between the two objects is called heat.

5. LAW OF CONSERVATION OF ENERGY

According to the law of conservation of energy, it can neither be created nor destroyed. It can only be changed from one form to another. Thus, the total energy before and after the transformation always remains constant.

MULTIPLE CHOICE QUESTION

1. For burning of coal in a thermoelectric station, the energy conversion taking place is:
(a) chemical to heat to mechanical
(b) chemical to heat to mechanical to electrical
(c) chemical to heat to light
(d) heat to chemical to mechanical

Ans : SQP 2025

The energy conversion that takes place in the burning of coal in a thermoelectric station is from chemical to heat to mechanical to electrical
Thus (b) is correct option.

2. The kinetic energy of a given body depends on the:
(a) position
(b) centre of gravity of the body
(c) momentum
(d) displacement

Ans : SQP 2025

$$\text{Kinetic energy} = \frac{p^2}{2m}$$

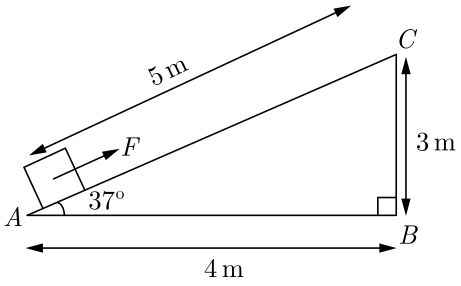
Where p = Momentum of body and
m = Mas of the body
Therefore, kinetic energy of a given body depends on the momentum.
Thus (c) is correct option.

3. When a bell fixed on a cycle rings, then the energy conversion that takes place is
(a) gravitational potential energy to sound energy
(b) kinetic energy to sound energy
(c) sound energy to electrical energy
(d) sound energy to mechanical energy

Ans : MAIN 2024

When a finger applies pressure to a bell fixed on a cycle, it rings. Thus, mechanical energy is transformed into sound energy.
Thus (b) is correct option.

4. A force 'F' moves a load from A to C as shown in the figure below. For the calculation of the work done, which of these lengths would you use as the displacement?



(a) 3 m (b) 4 m
(c) 5 m (d) 7 m

Ans : MAIN 2024

Displacement should be in the direction of force.
Thus (c) is correct option.

5. 1 J = ... erg
(a) 10^9 (b) 10^7
(c) 10^5 (d) 10^6

Ans : SEM-I 2021

The relation between Joule end Erg is

$$1\ \text{J} = 10^7\ \text{erg}$$

Thus (b) is correct option.

6. A coolie raises a load upwards against the force of gravity, then the work done by the load is
(a) zero (b) positive work
(c) negative work (d) None of these

Ans : SEM-I 2021

The coolie raises load in the upward direction and the force of gravity is in downward direction.

So, $\text{work done} = |F||s|\cos 180°$

$$= -|F||s|$$

Thus (c) is correct option.

7. A light body A and a heavy body B have the same momentum.
(i) Choose a correct statement from the given options.
(a) Kinetic energy of body A and body B will be the same.
(b) Kinetic energy of body A is greater than kinetic energy of body B.
(c) Kinetic energy of body B is greater than kinetic energy of body A.
(d) Unless we know the velocity, we cannot find which body has greater kinetic energy.

Downloaded from www.pdf.tube

Ans : SEM-I 2021

$$\text{Kinetic energy} = \frac{(\text{momentum})^2}{2 \times \text{mass}}$$

$$(KE)_A = \frac{(p)}{2M_A}$$

$$(KE)_B = \frac{(p)}{2M_B}$$

Here, $M_A < M_B$

So, $(KE)_A > (KE)_B$

Thus (b) is correct option.

(ii) If the ratio of kinetic energies of A and B is 5 : 2, then which one of the following gives the mass ratio of the bodies respectively?

(a) 5 : 2 (b) 25 : 4
(c) 2 : 5 (d) 4 : 24

Ans : SEM-I 2021

Given, $\frac{(KE)_A}{(KE)_B} = \frac{5}{2}$

$$\frac{(KE)_A}{(KE)_B} = \frac{M_B}{M_A}$$

$$\frac{M_B}{M_A} = \frac{5}{2}$$

$$\frac{M_A}{M_B} = \frac{2}{5}$$

Thus (c) is correct option.

8. The energy change during photosynthesis in plants is

(a) heat to chemical (b) light to chemical
(c) chemical to light (d) chemical to heat

Ans : SEM-I 2021

During photosynthesis, solar energy is trapped by leaves and gets converted into chemical energy.
Thus (b) is correct option.

9. A body of mass 200 g falls freely from a height of 15 m. (Take, $g = 10$ ms^{-2})

(i) When the body reaches 10 m above the ground, its potential energy will be

(a) 20000 J (b) 10 J
(c) 10000 J (d) 20 J

Ans : SEM-I 2021

$$\text{Mass of the body} = 200 \text{ g} = 0.2 \text{ kg}$$

$$\text{Height} = 15 \text{ m}$$

$$\text{Potential energy} = mgh$$

$$= \frac{200}{1000} \times 10 \times 10 = 20 \text{ J}$$

Thus (d) is correct option.

(ii) The gain in kinetic energy of the body when it reaches 10 m above the ground is

(a) 20 J (b) 10 J
(c) 30 J (d) 25 J

Ans : SQP 2018

Gain in kinetic energy

$$= \text{Loss in potential energy}$$

$$= \text{mass} \times g \times \text{loss in height}$$

$$= 0.2 \times 10 \times 5$$

$$= 10 \text{ J}$$

Thus (b) is correct option.

(iii) The total mechanical energy it will possess, when it is just about to strike the ground is

(a) 30000 J (b) 20000 J
(c) 30 J (d) 20 J

Ans : SEM-I 2021

$$(\text{Total mechanical energy})_{\text{at bottom}}$$

$$= (KE)_{\text{at top}} + (PE)_{\text{at top}}$$

$$= 0 + mgh$$

$$= 0 + 0.2 \times 10 \times 15$$

$$= 30 \text{ J}$$

Thus (c) is correct option.

(iv) The velocity in ms^{-1} with which the body will hit the ground is

(a) 30 (b) 10
(c) $10\sqrt{3}$ (d) $10\sqrt{2}$

Ans : SEM-I 2021

Kinetic energy which hits the ground

$$= \frac{1}{2}mv^2$$

$$30 = \frac{1}{2}mv^2$$

$$30 \times 2 = 0.2v^2$$

$$\frac{60 \times 10}{0.2} = v^2$$

$$v = \sqrt{300} = 10\sqrt{3} \text{ m/s}$$

Thus (c) is correct option.

10. Work done = force × .....

(a) displacement (b) distance
(c) time (d) velocity

Ans : COMP 2023

The product of force and displacement is known as work.
Thus (a) is correct option.

NODIA

11. SI unit of power is .....
(a) joule. hour. (b) watt
(c) watt hour (d) kilowatt

Ans : SQP 2018

In the International System of Units (SI), the unit of power is the watt (W), which is equal to one joule per second.
Thus (b) is correct option.

12. Power rating of a pump =
(a) power output / power input
(b) power output × power input
(c) power input / power out put
(d) power output / time

Ans : MAIN 2012

Thus (a) is correct option.

13. Work done is positive when .....
(a) displacement is in direction of force applied
(b) distance is positive
(c) distance is negative
(d) maximum distance travelled along direction of force applied

Ans : COMP 2010

Direction of displacement decides if work done is positive or negative cannot definitely say.
Thus (a) is correct option.

14. In an oscillating pendulum the ..... energy is maximum at extremes.
(a) vibrational
(b) gravitational potential
(c) kinetic
(d) potential

Ans : COMP 2010

As it has attained a certain height about its mean position.
Thus (d) is correct option.

15. In a photovoltaic cell, ... energy converts to ..... energy.
(a) light, wind (b) thermal, kinetic
(c) light, electrical (d) heat, chemical

Ans : SQP 2017

A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon.
Thus (c) is correct option.

16. Power = ...
(a) time × work (b) work / time
(c) work × time (d) time / work

Ans : MAIN 2013

Power is defined as the rate at which work is done upon an object.
Thus (b) is correct option.

17. The two basic forms of mechanical energy are:
(a) Solar and wind
(b) Heat and tidal
(c) Sound and Light
(d) Potential energy and kinetic energy

Ans : COMP 2011

Two forms of mechanical energy are:
(i) Kinetic energy
(ii) Potential energy
Thus (d) is correct option.

18. During energy transformation some form of energy is given out without it being used anywhere. Such an energy is called .....
(a) stored energy
(b) dissipated form of energy
(c) wasteful energy
(d) backup energy

Ans : SQP 2009

Thus (b) is correct option.

19. SI unit of work is .....
(a) joule (b) dyne
(c) newton (d) erg

Ans : SQP 2008

The SI unit of work is joule (J). Joule is defined as the work done by a force of one newton causing a displacement of one meter.
Thus (a) is correct option.

20. In a washing machine the electrical energy is converted into .....
(a) mechanical kinetic rotational energy
(b) kinetic energy
(c) vibrational energy
(d) sound energy

Ans : MAIN 2004

In a washing machine, electrical energy is converted into mechanical energy. When a washing machine is operated, the tub inside the machine rotates when electricity is supplied to the machine. The tub's rotational motion is the washing machine's

Click Here to Buy book on Amazon

mechanical energy.
Thus (a) is correct option.

21. For a given mass and velocity the kinetic energy remains constant if ..... .
(a) mass and velocity both are squared.
(b) mass is four times and velocity is half.
(c) mass is half and velocity is doubled.
(d) none of the above.

Ans : SQP 2007

$$KE = \tfrac{1}{2}mv^2 \qquad ...(1)$$

when mass is four times and velocity is half.

$$(KE)_1 = \frac{1}{2}(4m) \times (\tfrac{v}{2})^2 \qquad \text{(From eq.1)}$$

$$= (KE)_1$$

Thus (b) is correct option.

22. When camphor sublimes .....
(a) it simply converts into gaseous state without attaining the liquid state.
(b) entire energy is lost to the surroundings.
(c) chemical energy changes into heat energy.
(d) Potential energy gets converted into kinetic energy.

Ans : COMP 2015

Sublimation process = solid state converts to gaseous state without the intermediate liquid state.
Thus (a) is correct option.

23. Work done by buoyant force is .....
(a) negative
(b) zero
(c) cannot definitely say
(d) positive

Ans : SQP 2020

It depends on whether the body is displaced or not due to buoyant force.
Thus (c) is correct option.

24. Energy is .....
(a) capacity to produce power
(b) capacity to do work
(c) capacity to do work per unit time
(d) the capacity to use power

Ans : MAIN 2022

Thus (b) is correct option.

25. Kinetic energy of a body is independent of .....
(a) time for which force is applied
(b) elasticity of the body
(c) force applied
(d) none of the above

Ans : COMP 2017

Whether rigid or elastic the kinetic energy does not have any influence.
Thus (b) is correct option.

26. A body possesses kinetic energy of 'X' J. If the mass of body increases 49 times determine its final velocity if Kinetic energy remains constant.
(a) 1/X the original velocity.
(b) $1/5^{\text{th}}$ the original velocity
(c) 1/2 the original velocity
(d) $1/7^{\text{th}}$ the original velocity

Ans : SQP 2019

$$KE_1 = KE_2$$

$$\frac{1}{2}m_1v_1^2 = \frac{1}{2}m_2v_2^2$$

$$m_1v_1^2 = m_2v_2^2$$

$$m_1v_1^2 = (49m_1)v_2^2$$

$$v_1^2 = (49)v_2^2$$

$$v_1 = 7v_2$$

$$v_2 = \frac{1}{7}v_1$$

Thus velocity should be reduced to 1/7th of the original value.
Thus (d) is correct option.

27. The mass equivalent of 500 liters of water is ..... kg.
(a) 50 kg (b) 500 kg
(c) 5 kg (d) none of these

Ans : MAIN 2011

Litre of water is equivalent to 1 kg of water.
Thus (b) is correct option.

28. The bullet weighing 100 g is released from the barrel of an air gun with a velocity of $4ms^{-1}$. Calculate the potential energy of the spring?
(a) 8 J (b) 0.8 J
(c) 800 J (d) 0.08 J

Ans : COMP 2007

Kinetic energy of the bullet is potential energy of spring.

$$\text{Kinetic energy of bullet} = \frac{1}{2}mv^2$$

Downloaded from www.pdf.tube

$$= \frac{1}{2} \times \frac{100}{1000} \times (4)^2$$

$$= 0.8 \text{ J}$$

Thus (b) is correct option.

29. 1 kW = ...
(a) 1000 J / 1000 sec (b) 10^{-3} W
(c) 100 J / 100 sec (d) 1000 W

Ans : MAIN 2010

Conversion of kilowatt to watt is multiply by 1000.
Thus (d) is correct option.

30. A construction worker holds a heavy tool box. How much work is done by the worker?

(a) $1/2mv^2$ (b) zero
(c) mgh (d) none of the above

Ans : SQP 2002

Thus (b) is correct option.

31. 1 dyne-cm = ...
(a) 10 newton cm (b) 1 erg
(c) 1 newton cm (d) none of these

Ans : COMP 2019

Dyne per Square Centimeter is one of the smallest pressure units and is derived from the CGS unit for force where 1dyne equals 1 gram accelerated by 1 centimeter per second per second.
Thus (b) is correct option.

32. What is the amount of force required to be applied on a body so as to displace it through 20 m performing 8000 J of work?
(a) 400 N (b) 400 J
(c) 40 N (d) 40 J

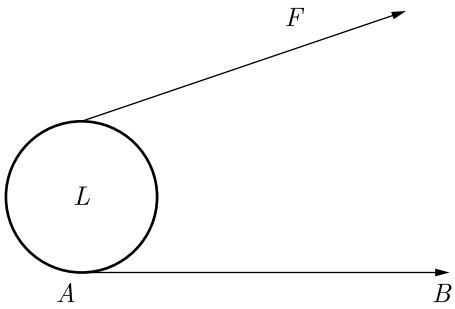
Ans : MAIN 2021

$$\text{Work done} = \text{force} \times \text{displacement}$$

$$\text{Force} = \frac{8000}{20} = 400 \text{ N}$$

Thus (a) is correct option.

33. A boy drags a load L along horizontal plane AB by applying a force F. The boy does



(a) some positive work (b) no work
(c) negative work (d) none of these

Ans : SQP 2023

Thus (a) is correct option.

34. Kilo-calorie is the amount of heat required to raise the temperature of :
(a) 1 kg of water through 10°C
(b) one kg of water through 1°C
(c) one gram of water through 1°C
(d) 1 kg of water through 100°C

Ans : COMP 2020

One kilocalorie is the amount of heat required to raise the temperature of 1 kilogram (or 1 liter) of water, 1°C.
Thus (b) is correct option.

35. What force must be applied to a body through a distance of 10 m, such that it does a work of 4000 J. If the mass of the body is 20 kg, what is the acceleration of the body ?
(a) 20 ms^{-2} (b) 10 ms^{-2}
(c) 40 ms^{-2} (d) 30 ms^{-2}

Ans : SQP 2021

$$\text{Force } F = \frac{\text{work done}}{\text{displacement}}$$

$$F = \frac{4000}{10} = 400 \text{ N}$$

$$a = \frac{F}{m} = \frac{400}{20} = 20 \text{ ms}^{-2}$$

Thus (a) is correct option.

36. An electric pump is 60% efficient and is rated 2 HP. Calculate the maximum amount of water it can lift through a height of 5 m in 40 s.
[Take $g = 10 \text{ ms}^{-2}$ and 1 HP = 750 W]
(a) 25 kg (b) 38 kg
(c) 720 kg (d) 280 kg

NODIA

Ans : MAIN 2018

$$\text{Power of lift pump} = 2 \text{ HP}$$
$$= (2 \times 750) \times \frac{60}{100}$$
$$= 15 \times 60 \text{ W}$$
$$p \times t = \text{Work done}$$
$$15 \times 60 \times 40 = (\text{mg}) \times \text{displacement}$$
$$15 \times 2400 = (m \times 10) \times 5$$
$$\text{Mass of water, } m = \frac{15 \times 2400}{50} = 720 \text{ kg}$$

Thus (c) is correct option.

37. The heart of a normal person beats 72 times in a minute and does a work of 1 joule per beat. What is power of the heart ?

(a) 1.5 W (b) 1.2 W
(c) 2.2 W (d) 1.7 W

Ans : COMP 2015

$$\text{Work done per beat} = 1 \text{ J}$$
$$\text{Work done for 72 beats} = 72 \text{ J}$$

Hence, $$\text{Power, } P = \frac{\text{work done}}{60}$$
$$= \frac{72}{60} = 1.2 \text{ W}$$

Thus (b) is correct option.

38. For a given mass of a body if velocity is doubled the kinetic energy is ..... .

(a) four times (b) 114 th
(c) halved (d) none of these

Ans : MAIN 2004

$$(\text{K.E.})_1 = \frac{1}{2}mv^2 \quad \ldots(\text{i})$$

According to the question.

$$v' = 2v$$

Now, $$(\text{K.E.})_2 = \frac{1}{2}m(2v)^2$$
$$= 4\left(\frac{1}{2}mv^2\right)$$

From equation (i), we have

$$= 4(K.E)_1$$

Thus (a) is correct option.

39. In an oscillating pendulum, kinetic energy is ..... at extremes.

(a) positive (b) zero
(c) negative (d) none of these

Ans : COMP 2015

It has the maximum kinetic energy at its extreme position. It has the maximum potential energy at its rest position. The sum of its kinetic and potential energies remains constant throughout the motion.

Thus (b) is correct option.

40. When a substance melt .....

(a) energy change takes place but is totally dissipated
(b) PE changes into KE
(c) no energy change takes place
(d) none of the above

Ans : SQP 2018

Solid state converts into liquid state then potential energy is converted into kinetic energy.

Thus (b) is correct option.

41. A scooter develops a power of 1 HP while running at 36 km hr^{-1}. Calculate the force generated by its engine.

(a) 60 N (b) 45 N
(c) 80 N (d) 75 N

Ans : SQP 2013

$$\text{Power } P = \frac{\text{work done}}{t}$$
$$= F \times \frac{s}{t}$$
$$P = F \times v$$
$$1 \times 750 = F \times \frac{36000}{(60 \times 60)}$$
$$F \times 10 = 750$$
$$F = \frac{750}{10} = 75 \text{ N}$$

Thus (d) is correct option.

42. A women pushes a trunk on railway platform which has a rough surface. She supplies a force of 100 N over a distance of 10 m. Thereafter, she gets progressively tired and her applied force reduces linearly with distance to 50 N. The total distance by which the trunk has been moved is 20 m. Calculate the net work done by the two forces over 20 m.

(a) 1500 J (b) 750 J
(c) 1000 J (d) 500 J

Ans : COMP 2014

The graph given below gives the force-distance variation.

Download NODIA App for All Sample Papers PDFs

Click Here to Buy book on Amazon

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

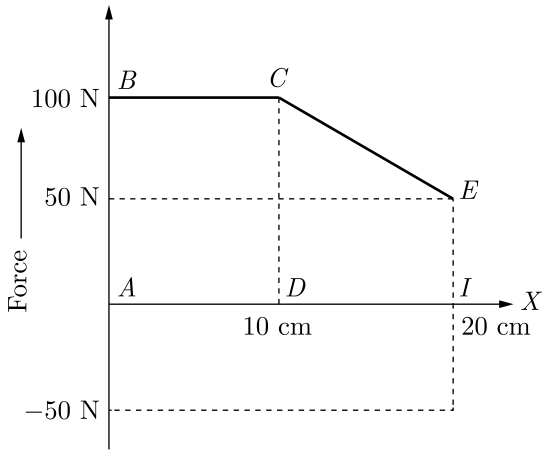
Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!



Its given frictional force = 50 N
As it opposes motions, acts in opposite direction.
Work done by the woman W_F = Area of rectangle $ABCD$ + Area of trapezium $CEID$

$$= 100 \times 10 + \frac{1}{2} \times (100 + 50) \times 10$$

$$= 1000 + 750 = 1750 \text{ N}$$

Work done by the frictional force is − 1000 N.
Hence, net work done

$$= 1750 - 1000 = 750 \text{ J}$$

Thus (b) is correct option.

43. The total work done on a particle is equal to the change in its kinetic energy
(a) only if elastic force alone acts on it
(b) always, if force is conservative
(c) only if gravitational force alone acts on it
(d) None of the above

Ans : MAIN 2010

From work-energy theorem or work-energy principle, total work done by the net force acting on a body is equal to change produced in kinetic energy of the body for constant force.
Thus (b) is correct option.

44. A pump motor is used to deliver water at a certain rate from a given pipe. To obtain twice as much water from the same pipe in the same time, the power of the pump has to be increased to
(a) 4 times (b) 2 times
(c) 16 times (d) 8 times

Ans : SQP 2009

$$\text{Power} = \text{Force} \times \text{Velocity}$$

Velocity has to be increased by twice mass of water flowing from same pipe, hence

$$\frac{\text{mass}}{\text{time}} = \frac{\text{volume} \times \text{density}}{\text{time}}$$

$$= \frac{v \times d}{t}$$

$$= \frac{\text{area} \times \text{length} \times \text{density}}{\text{time}}$$

$$= a \times \rho \times \text{velocity}$$

Rate of increase of KE is given by

$$= \frac{mv^2}{2 \times \text{time}}$$

$$= \frac{A \times \rho \times \text{velocity} \times v^2}{2}$$

$$= \frac{A \times \rho \times v^2}{2}$$

NODIA

Mass m flowing out per second can be increased to m_1, by increasing v to v_1, then power increases from P to P_1.

$$\frac{P_1}{P} = \frac{A \times \rho \times v_1^3}{A \times \rho \times v^3} = \frac{v_1^3}{v^3}$$

But given, $m_1 = 2m$, $v_1 = 2v$, then

Hence, $\frac{P_1}{P} = 2^3 = 8$

$$P_1 = 8P$$

Thus (d) is correct option.

45. A parrot flying at a height of 300 m above sea level with a force of 10 N .....
(a) does work equal to 3000 J
(b) does negative work
(c) does no work
(d) none of the above

Ans : COMP 2008

Flapping of wings applies force in the downward direction and displacement is horizontal so angle is 90 degree and hence work done is zero.
Thus (c) is correct option.

46. Force = Power × .....
(a) $[\text{velocity}]^2$ (b) velocity
(c) $\sqrt{\text{velocity}}$ (d) 1/velocity

Ans : SQP 2016

$$\text{Power} = \text{Force} \times \text{Velocity}$$

Thus (b) is correct option.

47. During free fall the total energy at 3/4th the height is .....
(a) gravitational potential energy at the top
(b) constant
(c) $3/4^{\text{th}}$ the initial potential energy.
(d) zero

Ans : MAIN 2010

According to the conservation of energy the total energy is conserved it mean energy remains constant.
Thus (b) is correct option.

48. An aeroplane is flying at an altitude of 10,000 m at a speed of 300 km/hour. The aeroplane at this height has :
(a) zero kinetic and potential energy
(b) only potential energy
(c) only kinetic energy
(d) both kinetic and potential energy

Ans : SQP 2018

In the given case, the aeroplane is at a certain height so it has potential energy. It also has kinetic energy because it is moving at a certain speed.
Thus (d) is correct option.

49. An engine of power 200 W, operates for 4 s. Find the work done by the engine. If the force developed by the engine is 100 N calculate the maximum displacement caused.
(a) 8 m (b) 2 m
(c) 5.6 m (d) 3.8 m

Ans : MAIN 2020

$$p = 200 \text{ W} \; ; \; t = 4 \text{ s}$$

$$\text{Work done} = p \times t$$

$$200 \times 4 = 800 \text{ J}$$

$$\text{Displacement} = \frac{W}{F} = \frac{800 \text{ J}}{100 \text{ N}} = 8 \text{ m}$$

Thus (a) is correct option.

50. In a hydroelectric power station, 1000 kg of water is allowed to drop a height of 100 m in 1 s. If the conversion of potential energy to electric energy is 60%, calculate the output power.
[Take $g = 10 \text{ ms}^{-2}$]
(a) 4×10^5 W (b) 1.5×10^5 W
(c) 8×10^5 W (d) 6×10^5 W

Ans : COMP 2023

$$\text{Output power} = \left(\frac{mgh}{t}\right) = \frac{\text{work done}}{\text{time}}$$

$$p \times \frac{100}{60} = \frac{1000 \times 10 \times 100}{1}$$

$$p = \frac{10^6 \times 10 \times 60}{100}$$

$$= 6 \times 10^5 \text{ W}$$

Thus (d) is correct option.

51. The SI unit of work is joule. It is expressed in terms of mass, length and time as
(a) $\text{kg m}^3\text{s}^{-2}$ (b) $\text{kg}^2\text{m}^2\text{s}^{-2}$
(c) $\text{kg m}^2\text{s}^{-3}$ (d) $\text{kg m}^2\text{s}^{-2}$

Ans : COMP 2015

$$\text{Work} = \text{Force} \times \text{Displacement}$$

$$1 \text{ Joule} = 1 \text{ Newton} \times 1 \text{ m}$$

$$= 1 \text{ kg} \times \text{m} \times \text{s}^{-2} \times 1 \text{ m}$$

$$1 \text{ J} = 1 \text{ kg} \times \text{m}^2 \times \text{s}^{-2}$$

Thus (d) is correct option.

52. A body P has kinetic energy E. Another body Q, whose mass is 9 times than P, also has kinetic energy E. Calculate the ratio of velocities of P and Q.
(a) 2 : 1 (b) 1 : 1
(c) 4 : 1 (d) 3 : 1

Ans : SQP 2000

According to the question,

For body P, $\text{K.E.} = \frac{1}{2} m v_1^2$ ...(i)

For body Q, $\text{K.E.} = \frac{1}{2} (9m) v_1^2$ ...(ii)

The kinetic energy in both condition is same ,we get

$$\frac{1}{2}(9m) v_1^2 = \frac{1}{2} m v^2$$

$$9 v_1^2 = v^2$$

Hence, $$v_1 = \frac{v_2}{3}$$

$$\frac{v_2}{v_1} = \frac{1}{3} = 1:3$$

Thus (d) is correct option.

53. Calculate the kinetic energy of a body of mass 100 g and having a momentum of 20 kg ms.
(a) 3975 J (b) 1580 J
(c) 3750 J (d) 2000 J

Ans : MAIN 2010

$$\text{Mass of the body } m = 100 \text{ g}$$

$$= \frac{100}{1000} = \frac{1}{10} \text{ kg}$$

$$\text{Momentum } p = mv$$

$$20 = \frac{1}{10} v$$

$$v = 200 \text{ ms}^{-1}$$

$$\text{K.E.} = \frac{1}{2} m v^2$$

Downloaded from www.pdf.tube

$$= \frac{1}{2} \times \frac{1}{10} \times 200 \times 200$$

$$= 2000 \text{ J}$$

Thus (d) is correct option.

54. A boy P has a mass of 20 kg and is moving with a velocity of 5 ms^{-1}. Another boy Q has a mass of 5 kg and is moving with a velocity of 20 ms^{-1}. Calculate the ratio of the momentum of P and Q.

(a) 1 : 1 (b) 2 : 1
(c) 3 : 2 (d) 1 : 2

Ans : COMP 2000

For P, $m = 20$ kg, $v = 5$ m/s

For Q, $m = 5$ kg, $v = 20$ m/s

$$P = mv$$

Therefore, we get

$$\frac{\text{Momentum of } P}{\text{Momentum of } Q} = \frac{20 \times 5}{5 \times 20} = \frac{1}{1}$$

Thus (a) is correct option.

55. If the force acting on a body is inversely proportional to its speed, then its kinetic energy is

(a) a constant
(b) inversely proportional to time
(c) linearly related to time
(d) inversely proportional to the sequence of time

Ans : SQP 2000

As the force is inversely proportional to speed in this question,

$$KE = \frac{1}{2}mv^2$$

As $$F = ma = \frac{m(v-u)}{t},$$

as F increases v decreases,

as $v = \frac{s}{t}$, hence KE is linearly related with time.

Thus (c) is correct option.

56. The heart of a deer chased by a tiger beats 200 times in a minute and does a work of 1.4 joules per beat. What is the power of heart ?

(a) 4.670 (b) 1.000
(c) 12.300 (d) 8.760

Ans : MAIN 2001

$$\text{Heart beats per minute} = 200$$

$$\text{Work done for 200 heart beats} = 200 \times \frac{14}{10}$$

$$= 280 \text{ J}$$

$$\text{Now, Power } P = \frac{\text{Force} \times \text{displacement}}{\text{time in sec.}}$$

$$= \frac{280}{60} = 4.6700$$

Thus (a) is correct option.

57. The figure shows a girl pulling 5 balloons in her hand for 12 m with a force of 1 N at an angle of 60° below horizontal. How much work does the girl do on the balloons?

(a) 6 J (b) –10 J
(c) 12 J (d) –6 J

Ans : COMP 2020

$$\text{Work done} = F\cos\theta \times S$$

$$= 1 \times \cos 60^\circ \times 12$$

$$= 1 \times \frac{1}{2} \times 12 = 6 \text{ J}$$

Thus (a) is correct option.

58. Calculate the time for which a motor pump of 10 HP and efficiency 80% must be switched on, so as to pump 20 m^3 of water through a vertical height of 20 m.
[Density of water $= 1000 \text{ kg m}^{-3}$; $g = 10 \text{ ms}^{-2}$; 1 HP = 750 W]

(a) 3975 dyne cm (b) 1580 dyne cm
(c) 3750 dyne cm (d) 2500 dyne cm

Ans : MAIN 2015

$$\text{Power of motor pump} = 10 \text{ HP}$$

$$= (10 \times 750) \times \frac{80}{100}$$

$$p \times t = \text{Work done}$$

$$6000 \times t = F \times \text{Displacement}$$

$$6000 \times t = mg \times 20$$

$$6000t = 20 \times 10^3 \times 10 \times 20$$

$$t = \frac{2000 \times 2000}{6000}$$

$$= 666.67 \text{ seconds}$$

NODIA

Thus (d) is correct option.

59. A spring is kept compressed by a toy car of mass 100 g. On releasing the pressure the car moves out with a speed of 0.5 ms^{-1}. Calculate the potential energy of the compressed spring.

(a) 0.0395 J (b) 0.0125 J
(c) 0.0375 J (d) 0.0250 J

Ans : SQP 2012

$$\text{Kinetic energy} = \text{P.E.}$$
$$= \frac{1}{2}mv^2$$
$$= \frac{1}{2} \times \frac{100}{1000}\text{kg} \times 0.5 \times 0.5$$
$$= \frac{1}{20} \times \frac{25}{100}$$
$$= \frac{12.5}{1000} = 0.0125 \text{ J}$$
$$\text{Potential energy} = 0.0125 \text{ J}$$

Thus (b) is correct option.

60. For how long must an electric motor pump of 2 HP operate, so as to pump 5 m^3 of water from a depth of 15 m.

[Take g = 10 N/kg, 1 m^3 of water = 10^3 kg]

(a) 6 min 15 s (b) 4 min 35 s
(c) 10 min 55 s (d) 8 min 20 s

Ans : SQP 2009

$$\text{Power} = 2 \text{ HP} = 2 \times 750 \text{ W}$$
$$p \times t = \text{work done}$$
$$2 \times 750 \times t = (\text{mass} \times \text{g}) \times \text{displacement}$$
$$2 \times 750 \times t = (5 \times 10^3 \text{ kg}) \times 10 \times 15 \text{ m}$$
$$t = \frac{750 \times 10^3}{2 \times 750}$$
$$= \frac{1000}{2}$$
$$= 500 \text{ s} = \frac{500}{60} = 8 \text{ min } 20$$

Thus (d) is correct option.

61. A pendulum is oscillating freely. Its bob has :

(a) maximum potential energy at its mean position
(b) only kinetic energy
(c) a constant energy which is, the sum of potential and kinetic energy
(d) maximum kinetic energy at extreme position

Ans : COMP 2007

Thus (c) is correct option.

62. One horse power is equal to :

(a) 700 W (b) 1000 W
(c) 764 W (d) 746 W

Ans : MAIN 2006

One Horse Power is defined as the amount of work that can be done by a standard horse in one second.

In the International System of Units (SI) the electrical equivalent of one horsepower is equal to 746 watts.

Thus (d) is correct option.

63. Gravitational potential energy = ...

(a) 2 mgh (b) mgh
(c) $\frac{1}{2}mv^2$ (d) none of these

Ans : SQP 2005

Gravitational potential energy = work done in reaching a height

Thus (b) is correct option.

64. A falling raindrop has

(a) only kinetic energy
(b) both kinetic and potential energy
(c) only potential energy
(d) none of these

Ans : SQP 2010

The water drop is at a certain height from the ground level, so it has the potential energy.

The raindrop is falling i.e., the drop is in the state of motion, so it possesses the kinetic energy too.

Thus (b) is correct option.

65. A body possesses a linear momentum of 20kgms^{-1} and mass of 2 kg. Calculate kinetic energy of the body.

(a) 100 J (b) 500 J
(c) 10 J (d) 5 J

Ans : COMP 2000

$$\text{KE} = \frac{p^2}{2m} = \frac{(20)^2}{2 \times 2} = \frac{400}{4}$$
$$= 100 \text{ J}$$

Thus (a) is correct option.

NO NEED TO PURCHASE SAMPLE PAPERS
Download India's Best 20 Sample Papers
DOWNLOAD NODIA APP
Every School conduct Pre-Board From These Sample Papers

Click Here to Buy book on Amazon

66. A weight lifter lifts a load of 250 N while a coolie lifts same load on his head. If the height of weight lifter and coolie is same, compare the work done?

(a) work done by weight lifter is more
(b) Work done is same
(c) work done by coolie is more
(d) none of the above

Ans : COMP 2010

Displacement of load is more in case of weight lifter so more work is done.
Thus (a) is correct option.

67. A catapult throws a stone of mass 0.10 kg with a velocity of 30 ms^{-1}. If 25% of the potential energy of the elastic band is wasted during transmission, find the magnitude of the potential energy.

(a) 78 J (b) 60 J
(c) 375 J (d) 215 J

Ans : SQP 2021

Let, potential energy = P.E.

P.E. wasted = 25%

P.E. used = $100 - 25 = 75\%$

Hence, 75% of P.E. = K.E. = $\frac{1}{2}mv^2$

$$\frac{75}{100}PE = \frac{1}{2} \times 0.10 \times 30 \times 30$$

$$PE = \frac{90}{2} \times \frac{100}{75}$$

$$= 45 \times \frac{4}{3} = 60 \text{ J}$$

Thus (b) is correct option.

68. Calculate the height through which a crane can lift a load of 4 t, when its motor of 4 HP operates for 10 s. [Take g = 10 ms^{-2}]

(a) 3.80 m (b) 0.75 m
(c) 1.27 m (d) 2.98 m

Ans : MAIN 2019

Given, $t = 10$ s

Mass = $m = 4t$

$= 4 \times 1000 = 4000$ kg

Force $F = mg = 4000 \times 10$ N

Work done = $F \times h$

$= 4000 \times 10$ h

Power = 4 HP = 4×750 W

$P = \frac{w}{t}$

$4 \times 750 = \frac{4000 \times 10 \times h}{10}$

$h = \frac{3000}{4000} = 0.75$ m

Thus (b) is correct option.

69. A pump of 200 W power is lifting 2 kg water per second from an average depth of 10 m. The velocity with which water comes out of the pump is (Take, $g = 9.8\, ms^{-2}$)

(a) 2.5 ms^{-1} (b) 2 ms^{-1}
(c) 10.2 ms^{-1} (d) 4 ms^{-1}

Ans : COMP 2013

Power of the pump = 200 W

Mass of water = 2 kg

Depth, h = 10 m

Hence, Power = Force × Velocity

$$\text{Velocity} = \frac{\text{Power}}{\text{Force}}$$

$$= \frac{200}{mg}$$

$$= \frac{200}{2 \times 9.8}$$

$$= 10.20\, ms^{-1}$$

Thus (c) is correct option.

NODIA

70. Power is the product of
(a) force and time
(b) force and acceleration
(c) force and displacement
(d) force and velocity

Ans : SQP 2022

Power is the product of force and velocity.
Thus (d) is correct option.

71. An electron and proton are detected in a cosmic ray experiment, the first with kinetic energy 10 keV and the second the 100 keV. Obtain the ratio of their speeds. (Take, electron mass $= 9.11 \times 10^{-3}$ kg, proton mass $= 1.67 \times 10^{-27}$ kg and 1 eV $= 1.60 \times 10^{-19}$ V)
(a) 6.16 V (b) 12.81
(c) 11.62 V (d) 13.54

Ans : COMP 2013

$$\text{Kinetic energy of electron} = 10 \text{ KeV}$$

$$\text{Kinetic energy of proton} = 100 \text{ KeV}$$

$$\text{Mass of electron, } m_e = 9.11 \times 10^{-31} \text{ Kg}$$

$$\text{Mass or proton, } m_p = 1.67 \times 10^{-27} \text{ Kg}$$

As, $K = \frac{1}{2}mv^2$ or $v = \sqrt{\frac{2K}{m}}$

Hence, $\frac{v_e}{v_p} = \sqrt{\frac{K_e}{K_p} \times \frac{m_p}{m_e}}$

$$= \sqrt{\frac{10 \times 1.67 \times 10^{-27}}{100 \times 9.11 \times 10^{-31}}}$$

$$= \sqrt{\frac{167}{911} \times 10^3}$$

$$v_e = 13.54\, v_p$$

Hence, electron is travelling faster.
Thus (d) is correct option.

72. The engine of a car develops a power of 5 HP and force 500 N while running a uniform speed S. Calculate the value of S.
(a) 12.5 ms^{-1} (b) 7.5 ms^{-1}
(c) 33.5 ms^{-1} (d) 27.5 ms^{-1}

Ans : SQP 2014

$$\text{Power of engine} = \frac{\text{Force} \times \text{displacement}}{\text{time in sec.}}$$

$$5 \text{ HP} = F \times \text{velocity}$$

$$5 \times 750 = 500 \times \text{speed}$$

$$S = \frac{7500 \times 5}{500} = 7.5 \text{ ms}^{-1}$$

Thus (b) is correct option.

73. A spring is compressed by a ping pong ball of mass 100 g. On its release it flies with a velocity of 20 ms^{-1}. Find the elastic potential energy possessed by spring.
(a) 200 J (b) 2000 J
(c) 20 J (d) 2 J

Ans : MAIN 2016

Elastic potential energy = Kinetic energy of the ping pong ball

$$= \frac{1}{2}mv^2$$

$$= \frac{1}{2} \times \frac{100}{1000} \times (20)^2$$

$$= 20 \text{ J}$$

Thus (c) is correct option.

74. A ball of mass m is dropped from height h.
(a) kinetic energy of the ball at ground level is mgh.
(b) Potential energy of the ball at ground level is mgh.
(c) Potential energy of the ball at height h is mgh.
(d) both (b) and (c)

Ans : COMP 2008

Potential energy of the ball at height h is mgh
Thus (c) is correct option.

75. When a flash light is switched on the electric energy
(a) first changes to heat energy and then to light energy.
(b) directly changes to light energy.
(c) first changes to light energy and then to heat energy.
(d) none of above

Ans : MAIN 2013

When the flashlight is turned on, the chemical energy stored in batteries is converted into electrical energy that flows through wires of flashlight. This electrical energy is then transformed first into heat energy and then light energy.
Thus (a) is correct option.

76. A stone resting on the roof of a building has
(a) kinetic energy
(b) potential energy
(c) gravitational energy
(d) none of these

Ans : MAIN 2005

NODIA

The stone is resting on the roof that is it is at a certain height, so it possesses the potential energy. Thus (b) is correct option.

77. Calculate the horse power of the motor of an elevator, which can carry 10 persons of average mass 60 kg through a vertical height of 20 m in 30 s. [Take g = 10 N/kg]
(a) 2.17 H.P. (b) 6.98 H.P.
(c) 5.33 H.P. (d) 8.67 H.P.

Ans : COMP 2010

Total mass of 10 persons $= 60 \times 10 = 600$ kg

$$F = mg = 600 \times 10 = 6000 \text{ N}$$

Displacement, $h = 20$ m

Time, $t = 30$ s

Work done, $w = F \times h = 6000 \times 20$ J

$$\text{Power} = \frac{w}{t}$$

$$= \frac{(6000 \times 20)\,\text{J}}{30\,\text{s}} = 4000 \text{ W}$$

$$\text{Power in H.P.} = \frac{4000}{750} = \frac{16}{3} = 5.33 \text{ H.P.}$$

Thus (c) is correct option.

78. A beam of electrons has an energy of 1 joule. How many electrons are in the beam ? [1 eV $= 1.6 \times 10^{-19}$]
(a) 2.75×10^{18} electrons
(b) 1.75×10^{18} electrons
(c) 6.25×10^{18} electrons
(d) 4.95×10^{18} electrons

Ans : SQP 2015

Let there are n electrons in beam.

Energy of n electrons in beam = 1 J

$$n \times 1.6 \times 10^{-19}\text{J} = 1 \text{ J}$$

$$n = \frac{1}{1.6 \times 10^{-19}}$$

$$= \frac{100}{16} \times 10^{18}$$

$$n = 6.25 \times 10^{18} \text{ electrons}$$

Thus (c) is correct option.

79. A boy of mass 40 kg walks up a flight of stairs to a vertical distance of 12 m in a time interval of 40 s. Rate at which the boy is doing work against the force of gravity is
(a) 400 W (b) 500 W
(c) 100 W (d) 120 W

Ans : COMP 2017

mass of boy = 40 kg

Vertical distance, $h = 12$ m

Time interval = 40 s

Hence,
$$\text{power} = \frac{\text{work done}}{\text{time}}$$

$$= \frac{mgh}{t}$$

$$= \frac{40 \times 10 \times 12}{40}$$

$$= 120 \text{ W}$$

Thus (d) is correct option.

80. Calculate the kinetic energy of a body of mass 5 kg momentum 50 kg ms^{-1}.
(a) 250 J (b) 158 J
(c) 375 J (d) 279 J

Ans : MAIN 2011

Mass $m = 5$ kg

Momentum $p = mv = 50$ kg ms^{-1}

$$5v = 50$$

Hence,
$$v = \frac{50}{5} = 10 \text{ ms}^{-1}$$

$$\text{K.E.} = \frac{1}{2} \times 5 \times 10 \times 10$$

$$= 250 \text{ J}$$

Thus (a) is correct option.

81. Charging a lead accumulator ..... energy gets converted into chemical energy.
(a) electrical (b) heat
(c) light (d) sound

Ans : COMP 2000

Charging of any appliance is done by supplying electrical energy.
Thus (a) is correct option.

82. A pendulum is swinging freely. The bob of pendulum has:
(a) Maximum kinetic energy at its mean position.
(b) Maximum kinetic energy. at its extreme positions.
(c) Minimum kinetic energy. at its mean position.
(d) Both (b) and (c)

Ans : SQP 2000

The kinetic energy of the bob of the pendulum is zero at the extreme positions while its value is maximum when it passes through its mean position.
Thus (a) is correct option.

Downloaded from www.pdf.tube

83. A compressed spring is held near a small toy car of mass 0.15 kg. On the release of the spring, the toy car moves forward with a velocity of 10 ms^{-1}. Find the potential energy of the spring.

(a) 9.5 J (b) 7.5 J
(c) 14.0 J (d) 11.0 J

Ans : MAIN 2010

Given,

$$\text{Mass of car } m = 0.15 \text{ kg}$$

$$\text{Velocity } v = 10\, ms^{-1}$$

$$\text{Kinetic energy} = \frac{1}{2}mv^2$$

$$= \frac{1}{2} \times \frac{15}{100} \times 10 \times 10$$

$$= 7.5 \text{ J}$$

$$= \frac{1000}{98} \text{ m/s} = 10.2 \text{ m/s}$$

Thus (b) is correct option.

84. 1 J = ... kWh

(a) 3.6×10^{-6} (b) 3.6×10^{6}
(c) 0.278×10^{-6} (d) none of these

Ans : COMP 2012

$$1 \text{ kWh} = 3.6 \times 10^6$$

Thus (c) is correct option.

85. A body is moved along a straight road by a machine delivering constant power. The distance moved by the body in time t proportional to

(a) $t^{\frac{3}{4}}$ (b) $t^{\frac{1}{2}}$
(c) t^2 (d) $t^{\frac{3}{2}}$

Ans : SQP 2012

As the body is moving along a straight line, delivering constant power, distance moved by the body,

$$s = ut + \frac{1}{2}at^2$$

$$s = \frac{1}{2}at^2 \qquad [\text{Since } u = 0]$$

$$s^2 = \frac{1}{4}a^2t^4 \qquad ...(i)$$

We know, $\text{power} = \frac{\text{work}}{\text{time}} = \frac{F \times s}{t}$

$$= F \times v \qquad \text{Since } v = \frac{s}{t}$$

Since, $v = u + at$

For $u = 0,\ v = at$

$$P = F \times v = ma \times at$$

$$P = ma^2t$$

$$a^2t = \frac{P}{m}$$

Substituting $a^2t = \frac{P}{m}$ in Eq. (i), we get

$$s^2 = \frac{1}{2}a^2t \cdot t^3$$

Now, $a^2t = \frac{P}{m}$, substituting above equation,

$$s^2 = \left(\frac{1}{2} \cdot \frac{P}{m}\right)t^3$$

$$s = (\text{constant})t^{\frac{3}{2}}$$

Hence, $s \propto t^{\frac{3}{2}}$

Thus (d) is correct option.

86. If a body of mass 5 kg is lifted from the ground level to a height of 5m then ratio of its inertia is ..... .

(a) constant (b) 1 : 1
(c) same (d) not defined

Ans : COMP 2013

Inertia is independent of height.

Thus (b) is correct option.

87. A body of mass 20 kg is moving with a velocity of 1 ms^{-1}. Another body B of mass 1 kg is moving with a velocity of 20 ms^{-1}. Find the ratio of kinetic energy of A and B.

(a) 1 : 20 (b) 1 : 10
(c) 1 : 40 (d) 1 : 30

Ans :

Kinetic energy of body A is given by

$$K_A = \frac{1}{2}m_1v_1^2$$

$$= \frac{1}{2} \times 20 \times (1 \times 1) = 10 \text{ J}$$

Kinetic energy of body A is given by

$$K_B = \frac{1}{2}m_2v_2^2$$

$$= \frac{1}{2} \times 1 \times (20 \times 20) = 200$$

Now $\frac{K_A}{K_B} = \frac{10}{200}$

$$= 1:20$$

Thus (a) is correct option.

88. A lead pallet of mass 10 g leaves an air gun with a velocity of 40 ms^{-1}. What is the magnitude of potential energy stored by its spring ?

(a) 8 J (b) 2 J
(c) 37 J (d) 25 J

NODIA

Ans : SQP 2015

$$\text{Mass of lead pallet } m = \frac{10}{1000}$$

$$m = \frac{1}{100} \text{ kg}$$

$$\text{Velocity } v = 40 \text{ ms}^{-1};$$

$$\text{K.E.} = \frac{1}{2}mv^2$$

$$= \frac{1}{2} \times \frac{1}{100} \times 40 \times 40$$

$$= 8 \text{ J}$$

Hence, P.E. = K.E. = 8 J

Thus (a) is correct option.

89. Calculate the power of an electric pump in horse power, which can lift 2000 m^3 of water from a depth of 20 m in 25 minutes. [Take g $= 10 \text{ ms}^{-2}$ and 1 m^3 of water $= 10^3$ kg]

(a) 165.33 H.P. (b) 52.45 H.P.
(c) 355.55 H.P. (d) 218.83 H.P.

Ans : COMP 2017

$$1 \text{ m}^3 \text{ of water} = 10^3 \text{ kg}$$

Hence, 2000 m^3 of water has mass

$$= m = 2000 \times = 10^3 \text{ kg}$$

$$\text{Weight} = \text{force} = \text{mg}$$

$$= 2000 \times 10^3 \times 10\text{N}$$

$$\text{Displacement} = \text{depth} = 20 \text{ m}$$

$$\text{Work done, } W = F \times S$$

$$t = 25 \text{ min} = (25 \times 60) \text{ S}$$

$$\text{Power} = \frac{\text{work done}}{\text{t}}$$

$$= \frac{(2000 \times 10 \times 10^3) \times 20}{(25 \times 60)}$$

$$\text{Hence, Power in H.P.} = \frac{2000 \times 10^3 \times 200}{25 \times 60 \times 750}$$

$$= \frac{3200}{9} = 355.55 \text{ H.P.}$$

Thus (c) is correct option.

90. For a freely falling body the potential energy at the top .....

(a) is equal to gravitational potential energy
(b) is completely converted to KE
(c) is minimum
(d) is zero

Ans : SQP 2020

Thus (a) is correct option.

91. One electron volt is equal to :

(a) 6.1×10^{-19} J (b) 1.6×10^{-17} J
(c) 1.6×10^{-10} J (d) 1.6×10^{-19} J

Ans : COMP 2000

Thus (d) is correct option.

92. An accelerated electron has energy of 9.6×10^{-18} J. Express the energy in electron volts (eV)

(a) 30 eV (b) 10 eV
(c) 60 eV (d) 40 eV

Ans : SQP 2020

$$\text{Energy in 1 electron} = 9.6 \times 10^{-18} \text{ J}$$

$$= \frac{9.6 \times 10^{-18}}{1.6 \times 10^{-19}}$$

$$= \frac{9.6}{1.6} \times 10^{-18+19}$$

$$= 6 \times 10 = 60 \text{ eV}$$

Thus (c) is correct option.

93. Kilowatt hour is the commercial unit of :

(a) electric force
(b) electric power
(c) electric energy
(d) none of these

Ans : COMP 2000

Thus (c) is correct option.

ASSERTION AND REASON

94. **Assertion :** A crane P lifts a car up to a certain height in 1 min. Another crane Q lifts the same car up to the same height in 2 min. Then crane P consumes two times more fuel than crane Q.
Reason : Crane P supplies two times more power than crane Q.

(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

Since power is inversely proportional to time, crane P supplies more power.
Thus (a) is correct option.

Click Here to Buy book on Amazon

95. **Assertion :** The kinetic energy, with any reference, must be positive.
Reason : It is because, in the expression for kinetic energy, the velocity appears with power 2 and mass is a scalar quantity.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

Thus (a) is correct option.

96. **Assertion :** Work done by or against gravitational force in moving a body from one point to another is independent of the actual path followed between the two points.
Reason : Gravitational forces are conservative forces.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

From, definition, work done in moving a body against a conservative force is independent of the path followed.
Thus (a) is correct option.

97. **Assertion :** According to law of conservation of mechanical energy, change in potential energy is equal and opposite to the change in kinetic energy.
Reason : Mechanical energy is not a conserved quantity.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

For conservative forces the sum of kinetic and potential energies at any point remains constant throughout the motion. It does not depend upon time. This is known as law of conservation of mechanical energy. According to this rule.
Kinetic energy + Potential energy = E = constant
Thus (c) is correct option.

98. **Assertion :** The work done during a round trip is always zero.
Reason : No force is required to move a body in its round trip.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

This is typically true only in the special case of conservative force work but need not be true if F is not conservative.
Thus (c) is correct option.

99. **Assertion :** When the force retards the motion of a body, the work done is zero.
Reason : Work done depends on angle between force and displacement.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

Work done, $W = \vec{F}.\vec{s}$ For retarding, the force $\vec{F}$ should be inclined to $\vec{s}$ at angle θ such that $\frac{\pi}{2} < \theta < \pi$. For this angle $\cos\theta$ is negative, so work done is negative. Here negative work done implies that some external force is applied to change the state of a body.
Thus (d) is correct option.

NODIA

100. **Assertion :** A spring has potential energy, both when it is compressed or stretched.
Reason : In compressing or stretching, work is done on the spring against the restoring force.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

The work done on the spring against the restoring force is stored as potential energy in both cases, when it is compressed or stretched.
Thus (a) is correct option.

101. **Assertion :** A spring has potential energy, both when it is compressed or stretched.
Reason : In compressing or stretching, work is done on the spring against the restoring force.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

When spring is compressed or stretched, the work is done on the spring. Due to this work, the energy gets stored in it as elastic potential energy.
Thus (a) is correct option.

102. **Assertion :** When the force retards the motion of a body, the work done is negative.
Reason : Work done depends on angle between force and displacement.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

When the force retards the motion, the force and displacement are in opposite directions to each other. Hence, the work done by the force is negative.
Thus (b) is correct option.

103. **Assertion :** A winded toy car, when placed on floor, starts moving.
Reason : Toy car has kinetic energy stored in it which facilitates its motion.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

When a toy car is winded, work done on it gets stored in the form of elastic potential energy and when it is placed on the ground, this elastic potential energy slowly converts into kinetic energy of the toy and facilitates its motion.
Thus (c) is correct option.

104. **Assertion :** No work is done when a woman carrying a load on her head, walks on a level road with a uniform velocity.
Reason : No work is done if force is perpendicular to the direction of displacement.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

Work done $W = \vec{F} \cdot \vec{ds} = F\, ds \cos\theta = 0$ when $\theta = 90^\circ$. No work is done when force is normal to the displacement.
Thus (a) is correct option.

105. **Assertion :** Watt hour has units of energy.
Reason : Kilowatt hour (kW h) is the unit of electric power.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

Kilowatt (1000 watt) is the unit of power. Kilowatt hour is the power consumed in one hour = power $\times$ time = energy. One watt is equal to Joule per second. Hence, watt $\times$ time has units of energy.
Thus (c) is correct option.

106. **Assertion :** Work done by the gravitational force through a certain distance is constant irrespective of the fact that the body has a uniform or accelerated motion.
Reason : Gravitational force is a conservative force.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

Work done by the gravitational force is mgh.
Thus (b) is correct option.

FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

Downloaded from www.pdf.tube

ONE MARK QUESTIONS

DIRECTION : Complete the following with appropriate words.

107. If the mass as well as the velocity of a body is doubled then the kinetic energy of the body ..... (is doubled/becomes eight times / becomes four times) the initial kinetic energy.

Ans : SQP 2025

becomes eight times

108. Unit of power used in mechanical engineering is ..... (watt / horse power / erg per second)

Ans : SQP 2025

horse power

109. Work done by this force at any instant is ..... (zero / unit)

Ans : COMP 2010

zero

110. $1\,\text{kWh} = ... \text{J}$.

Ans : MAIN 2015

$3.6 \times 10^6 \text{J}$

111. A planet revolves around the sun due to ..... (gravitational/centripetal) force between it and the sun.

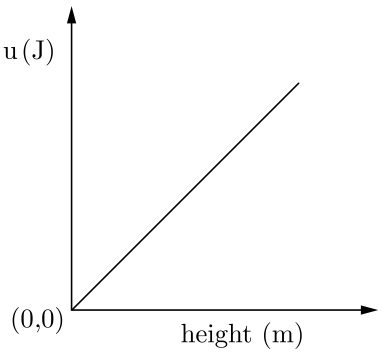
Ans :

Gravitational

DIRECTION : Answer the following :

112. Draw a graph of potential energy vs height for a body thrown vertically upwards. [Assume no friction is present.]

Ans : SQP 2025



113. Define a kilowatt hour. How is it related to joule ?

Ans : COMP 2020

It is the defined as the energy consumed when an agent of 1 kilowatt is used for 1 hour.

$$1\,\text{KW h} = 3.6 \times 10^6\,\text{J}$$

114. A satellite revolves around a planet in a circular orbit. What is the work done by the satellite at any instant? Give a reason.

Ans : SQP 2020

Zero, As the centripetal force acts on the satellite perpendicular to its motion.

115. A truck driver starts off with his loaded truck. What are the major energy changes that take place in setting the truck in motion?

Ans : COMP 2001

Chemical energy is converted into heat energy which is further converted into mechanical energy.

116. Name the physical quantity measured in terms of horse power.

Ans : MAIN 2015

Power

117. What do you mean by mechanical energy?

Ans : COMP 2016

Mechanical energy is the sum of kinetic energy and potential energy of a body.

118. A porter moving vertically up the stairs with a box on his head does work. Explain.

Ans : SQP 2018

A box is lifted vertically to the upstairs. He has vertical displacement against weight so the porter does work.

119. Name the three components of sunlight.

Ans : MAIN 2020

(i) Ultraviolet radiation
(ii) Visible light
(iii) Infrared radiation.

120. What should the angle between force and displacement be to get the
(i) minimum work
(ii) maximum work?

Ans : MAIN 2005

NODIA

(i) $\theta = 90^\circ$
(ii) $\theta = 0^\circ$

121. What is dissipation of energy ?

Ans : SQP 2021

In transforming the mechanical energy if a part of it gets converted into another form of energy which cannot be utilised for useful work, this loss of energy is called the dissipation of energy.

122. Define energy and give its nature and SI unit.

Ans : MAIN 2018

Energy of a body is defined as its capacity of doing work. It is a scalar quantity. Its SI unit is joule.

123. What is the work done by the moon when it revolves around the earth?

Ans : COMP 2014

When moon revolves around the earth, the work done by the moon is equal to zero.

124. Define solar energy.

Ans : SQP 2012

Solar energy is the energy obtained from the Sun.

125. A person continues to push a rock for sometime but fails to move it. What is the work done by it?

Ans : COMP 2011

Zero. As $W = Fs$ and $s = 0$, so work done is also zero.

126. Obtain the relation between kinetic energy K and momentum p of a body.

Ans : MAIN 2010

Let a body of mass (m) move with velocity v, so its kinetic energy

$$KE = \frac{1}{2}mv^2 \Rightarrow \frac{1}{2}(mv^2)\frac{m}{m} \Rightarrow$$

$$\frac{m^2v^2}{2m} \Rightarrow \frac{(mv)^2}{2m} = \frac{p^2}{2m}$$

127. Name the physical quantity that is measured in:
(a) kilowatt
(b) kilowatt hour

Ans : SQP 2005

(a) Power
(b) Electrical energy

128. What is the energy associated with a parrot flying in the air?

Ans : COMP 2001

A parrot flying possesses both potential and kinetic energies as it is at a certain height above the earth's surface and also moving with a certain velocity.

129. What is the S.I. unit of energy? How is the electron volt (eV) related to it?

Ans : MAIN 2007

The S.I. unit of energy is joule, $1\text{ eV} = 1.6\times10^{-19}$J.

130. Can a body have momentum without energy?

Ans : SQP 2006

No, If a body has momentum, it must be in motion and consequently possesses kinetic energy.

131. What is the relation between 1 kWh and 1 J?

Ans : MAIN 2008

$$\begin{aligned} 1\text{ kWh} &= 1\text{ kW} \times 1\text{ h} \\ &= 1000\text{ J/s} \times 3600\text{ s} \\ &= 3.6 \times 10^6\text{ J} \end{aligned}$$

132. Define work. Is work a scalar or a vector quantity ?

Ans : COMP 2010

Work is said to be done when the force applied on the body makes the body move. Work is a scalar quantity as it is the product of two vector quantities.

133. What do you mean by power ? What is its nature ?

Ans : COMP 2015

The rate of doing work is called power. If W is the total work done in time t, then

$$\text{Power, } (P) = \frac{\text{Work done } (W)}{\text{Time taken } (t)}$$

134. When does a force do work?

Ans : SQP 2014

A force does work when the applied force produces displacement in the direction of force.

FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

Click Here to Buy book on Amazon

TWO MARKS QUESTIONS

135. Why does it become pleasantly warm when the lakes start freezing?

Ans : MAIN 2024

When lake freezes, it released latent heat to the atmosphere which warms the atmosphere. So, the atmosphere becomes pleasantly warm.

136. Give one example of each when :
(i) Chemical energy changes into electrical energy.
(ii) Electrical energy changes into sound energy.

Ans : SQP 2020

(i) Electrochemical cell.
(ii) Loud speaker.

137. A boy weighing 40 kgf climbs up a stair of 30 steps each 20 cm high in 4 minute and a girl weighing 30 kgf does the same in 3 minutes. Compare :
(i) the work done by them.
(ii) the power developed by them.

Ans : MAIN 2016

(i) Equal work.
(ii) Power developed by the girl is more as she does the same work as the boy but is lesser time.

138. Explain briefly why the work done by a fielder when he takes a catch in a cricket match is negative.

Ans : COMP 2015

Work done by a fielder is negative during a catch in a cricket match as the force exerted on the ball and the displacement of the ball are in opposite directions, i.e. 180° with one another.

139. Explain the motion of a planet around the sun in a circular path.

Ans : SQP 2015

A planet revolves around the sun due to gravitational force between it and the sun. The gravitational force provides the necessary centripetal force for the circular motion.

140. State the energy changes in the following devices while in use:
(a) Burning of a candle.
(b) A steam engine

Ans : COMP 2015

(a) In burning of a candle, chemical energy changes to light energy and heat energy.
(b) In steam engine, chemical energy changes to heat energy which converts into mechanical energy.

141. Explain briefly why the work done by a fielder when he takes a catch in a cricket match is negative.

Ans : SQP 2015

When a cricketer catches the ball he applies a force opposite to the direction of motion of the ball. Since the displacement of the ball and the force applied are opposite, therefore, the work done is negative.

142. A man having a box on his head, climbs up a slope and another man having an identical box walks the same distance on a levelled road. Who does more work against the force of gravity and why ?

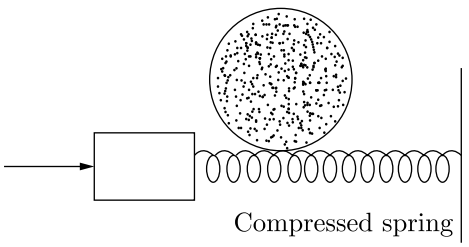
Ans : MAIN 2014

A man climbing up a slope does more work against force of gravity.
Work done by the force of gravity is

$$W = \text{force} \times \text{displacement}$$
$$= \text{weight} \times \text{height}$$
$$= mg \times h$$

When a man is climbing up a slope, h increases. Therefore, work done against force of gravity is more.

143. A ball is placed on a compressed spring. When the spring is released, the ball is observed to fly away.



(a) What form of energy does the compressed spring possess?
(b) Why does the ball fly away?

Ans : SQP 2012

(a) The compressed spring possesses elastic potential energy.

Downloaded from www.pdf.tube

(b) When the spring is released, the potential energy of the spring changes into kinetic energy which does work on the ball placed on the spring and makes the ball fly away.

144. A body is thrown vertically upwards. Its velocity keeps on decreasing. What happens to its kinetic energy as its velocity becomes zero ?

Ans : SQP 2014

Kinetic energy is given by $K = \frac{1}{2}mv^2$.

Therefore, if velocity becomes zero, kinetic energy also reduces to zero.

145. State the principle of conservation of energy. Name the form of energy which a body may possess even when it is not in motion.

Ans : COMP 2013

(i) Energy can neither be created nor can it be destroyed. It only changes from one form to another.
(ii) Potential energy.

146. (a) State the energy conversion taking place in a solar cell.
(b) Give one disadvantage of using a solar cell.

Ans : COMP 2012

(a) In a solar cell, solar energy (or light energy) converts into electrical energy.
(b) Solar cells cannot be used at night or in the darkness.

147. A coolie carrying a load on his head and moving on a frictionless horizontal platform does no work. Explain the reason why ?

Ans : MAIN 2011

When a coolie carrying a load on his head moves on a horizontal frictionless platform, the displacement is normal to the direction of force, therefore,

Work done, $W = Fs \cos 90°(\cos 90° = 0)$

148. A body is acted upon by a force. State two conditions under which the work done could be zero.

Ans : COMP 2010

Work done could be zero if:
(i) force and displacement are perpendicular to each other.
(ii) displacement is zero.

149. Which physical quantity does the electron volt measure ? How is it related to the SI unit of this quantity ?

Ans : SQP 2004

Electron volt is a unit of energy.
It is related to the SI unit as $1\,\text{eV} = 1.6 \times 10^{-19}$ joule.

NODIA

150. A body moves along a circular path. How much work is done in doing so? Explain.

Ans : SQP 2015

In case of a body moving along a circular path, the force (centripetal) is always along the radius while displacement is tangential. Hence, work done $W = Fs \cos 90° = 0$ as angle between F and s is 90°.

151. State the energy changes in an oscillating pendulum.

Ans : COMP 2004

There is an interchange in the kinetic and potential energy of the simple pendulum. At the mean position its energy is wholly kinetic and at the extreme position it is wholly potential. The kinetic energy changes to potential energy. When it moves from the mean position to the extreme position.

152. State the energy changes in the following cases while in use:
(i) An electric iron.
(ii) A ceiling fan.

Ans : SQP 2018

(i) Electrical into heat energy.
(ii) Electrical into mechanical energy.

153. Derive a relationship between SI and CGS unit of work.

Ans : COMP 2013

$$1\ \text{J} = 1\,\text{kg} \times 1\text{m}^2 \times 1\text{s}^{-2}$$
$$= 10^3\text{g} \times 10^4\text{cm}^2 \times 1\text{s}^{-2}$$
$$= 10^7\,\text{g cm}^2\text{s}^{-2}$$
$$= 10^7\text{erg}$$

154. How is work done by a force measured when the force:
(i) is in the direction of displacement ?
(ii) is at an angle to the direction of displacement?

Ans : COMP 2015

(i) $W = FS$
(ii) $W = FS\cos\theta$

155. State the energy changes in the following while in use:
(i) Burning of a candle.
(ii) A steam engine

Ans : SQP 2015

(i) Chemical energy into light and heat energy.
(ii) Heat energy into mechanical energy.

156. Does a coolie carrying load on his head do any work while standing or while moving? If not, why?

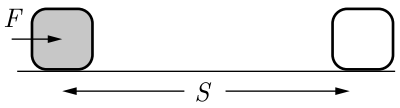
Ans : COMP 2010

No, while coolie is standing carrying a load on his head displacement is zero.
He does no work against the force of gravity, while moving on the ground since displacement is normal to the force of gravity.

157. Define work and explain how to measure it.

Ans : MAIN 2012

Work is said to be done when a force acts on a body which displaces the body in its own direction. Work done is measured by the product of the applied force (F) and the distance (s) through which the point of application moves in the direction of force applied.



Work done by a force

Work = Force × Displacement in the direction of force

$$W = Fs$$

158. What do you understand by potential energy of a body? Give its SI unit. Also give two examples from everyday life.

Ans : SQP 2014

The energy possessed by a body by virtue of its state or position is called its potential energy. Its SI unit is joule. Examples:
(i) A wound up spring.
(ii) When a stone is lifted from the ground to some height, work is done against the force of gravity which is stored in the stone in the form of its potential energy.

159. The work done in lifting a box on to a platform does not depend upon how fast it is lifted up. Explain your answer giving proper reasoning.

Ans : COMP 2018

The work done (W) in lifting a box through a distance S against the gravitational force (F) is given by W = FS. Hence, it is obvious that it is independent of the rate at which the box is lifted.

160. State the transformation of energy which takes place in the following when current is drawn from them :
(i) An electric cell
(ii) A generator

Ans : SQP 2019

(i) An electric cell : Chemical energy is transformed into electrical energy.
(ii) A generator : Mechanical energy is transformed into electrical energy.

161. How are kinetic energy and momentum related?

Ans : MAIN 2020

Kinetic energy is given by the relation $\mathrm{K} = \frac{1}{2}mv^2$.

Multiplying and dividing the right hand side of the equation by m,

we have $$\mathrm{K} = \frac{1}{2}\frac{(mv)^2}{m},$$

but $mv = p$ is Momentum of a body, therefore,

$p = \sqrt{2m\mathrm{K}}$.

162. What energy conversions take place in the following when they are working:
(a) electric toaster, and (b) microphone?

Ans : COMP 2023

(a) Electrical energy to heat energy.
(b) Sound energy to electrical energy.

163. Define 'joule', write SI unit of work and establish a relationship between the SI and CGS unit of work.

Ans : SQP 2021

One joule is defined as the work done when a force of one newton displaces a body through one metre in its own direction.
The SI unit of work is joule.

$$1\ \mathrm{J} = 1\ \mathrm{N} \times 1\ \mathrm{m}$$
$$= 10^5\ \text{dyne} \times 100\ \text{cm}$$
$$= 10^7\ \text{dyne cm} = 10^7\ \text{erg}$$

Click Here to Buy book on Amazon

164. What is the SI unit of power? How is it related to horse power?

Ans : MAIN 2023

The SI unit of power is joule/second. But in the honour of James Watt it is called by special name watt.

$$1\text{ watt} = \frac{1\text{ joule}}{1\text{ second}} \text{ or } \text{W} = 1\text{ J/s}$$

$$1\text{ horsepower} = 746\text{ watt}$$

165. State the amount of work done by an object when it moves in a circular path for one complete rotation. Give a reason to justify your answer.

Ans : COMP 2022

Here we know that work done = force × displacement

Amount of work done by an object moving in a circular path for one complete rotation will be zero as the displacement in one complete rotation is zero.

166. State the transformation of energy taking place in a:

(i) Loudspeaker

(ii) Washing machine

Ans : SQP 2023

(i) Loudspeaker : Electric energy is converted into sound energy.

(ii) Washing machine : Electric energy is converted into mechanical energy and sound energy.

167. What physical quantity does the electron volt (eV) measure ? How is it related to the SI unit of that quantity ?

Ans : MAIN 2015

eV is a small unit of energy. It is the energy possessed by atomic particles.

$$1\text{ eV} = 1.6 \times 10^{-19}\text{ J}$$

168. Two bodies of equal masses are moving with uniform velocities v and $2v$. Find the ratio of their kinetic energy.

Ans : COMP 2000

$$\text{KE} = \frac{1}{2}mv^2$$

If masses of two bodies are same, then K.E. of 1^{st} body is $\frac{1}{2}mv^2$ and K.E. of 2^{nd} body is $\frac{1}{2}m(2v)^2$. They will be in ratio of 1 : 4.

169. Write the type of energy involved in the following cases :

(i) A falling apple

(ii) A bent bow

Ans : SQP 2010

(i) Kinetic energy

(ii) Potential energy

170. State the energy changes that take place in the following when they are in use:

(a) a photovoltaic cell.

(b) an electromagnet.

Ans : MAIN 2012

(a) In a photovoltaic cell, light energy changes into electrical energy.

(b) In an electromagnet, electrical energy changes into magnetic energy.

171. State SI and CGS units of work.

Ans : COMP 2014

The SI unit of work is joule. Work is said to be one joule if a force of one newton displaces its point of application through one metre in its own direction. Thus,

$$1\text{ joule }(J) = 1\text{ newton }(N) \times 1\text{ metre }(m)$$

CGS unit of work is erg. Work is said to be one erg if a force of 1 dyne displaces its point of application through one centimetre in its own direction. Thus,

$$1\text{ erg} = 1\text{ dyne} \times 1\text{ cm}$$

172. A light and a heavy body have the same momentum. Which one will have greater kinetic energy ?

Ans : SQP 2016

As $K = \frac{p^2}{2\,\text{m}}$ and p is same for both.

Hence, $K \propto \frac{1}{m}$.

Thus, the lighter body has more kinetic energy than the heavier body.

173. Obtain the expression for potential energy.

Ans : MAIN 2019

Let a body of mass m be lifted from the ground to a vertical height h against force of gravity, *i.e.* Potential energy = Work done on the body to lift it to a height h

= Force × Displacement

NODIA

$$= mg \times h$$

$$\text{PE or } U = mgh$$

174. How is nuclear energy generated?

Ans : COMP 2022

In nuclear fission, the nucleus of a heavy atom such as uranium and plutonium on bombarding with low energy neutrons, splits apart into lighter nuclei and a large amount of energy is released which is called nuclear energy.

175. If the speed of a car is halved, by which factor does its kinetic energy change?

Ans : MAIN 2023

As we know that,

$$\text{KE} = \frac{1}{2}mv^2$$

Now, $v_1 = \frac{v}{2}$

$$(\text{KE})_1 = \frac{1}{2}mv_1^2 = \frac{1}{2}m\left(\frac{v}{2}\right)^2$$

$$= \frac{1}{4} \times \left(\frac{1}{2}mv^2\right) = \frac{1}{4}(\text{KE})$$

176. When an arrow is shot from its bow, it has kinetic energy. From where does it get the kinetic energy?

Ans : COMP 2022

A stretched bow possesses potential energy on account of a change in its shape. To shoot an arrow; the bow is released. The potential energy of the bow is converted into the kinetic energy of the arrow.

177. Give an example in which force does no work on the body.

Ans : SQP 2018

When a body is whirled around in a circle with uniform speed, *e.g.* a stone tied to the end of a string. The force is directed towards the centre and is, therefore, always normal to the direction of motion. Hence the work done ($W = Fs\cos 90° = 0$) is zero.

178. (a) Can a body have energy without having momentum? Explain.
(b) Can a body have momentum without having energy ? Explain.

Ans : COMP 2012

(a) Yes, because body at rest can have potential energy or energy stored due to position as elastic potential energy even if momentum is not there.
(b) No, if a body has momentum, it must be in motion so it must have some kinetic energy.

179. What are the limitations of the energy of moving water?

Ans : MAIN 2011

(i) Water should be available in sufficient quantity to rotate the blades of water wheel to produce electricity.
(ii) Falling water (natural waterfall) is not available at all places.

180. State the principle of conservation of energy.

Ans : COMP 2009

According to the principle of conservation of energy, energy can neither be created nor be destroyed. It can only be transformed from one form to another.

181. What type of energy is stored in the spring of a watch?

Ans : SQP 2010

When we wind a watch, the configuration of its spring is changed. The energy stored in the spring is obviously potential in nature (elastic potential energy to be more accurate).

182. The work done by a fielder when he takes a catch in a cricket match is negative. Explain.

Ans : MAIN 2000

Work done while taking a catch is negative because the force opposes the motion or tries to stop a moving body.

$$\text{Work done} = -\text{F} \times \text{S}$$

Hence, the work done is negative.

183. Write the circumstances in which work done by a force is zero.

Ans : SQP 2010

The amount of work done by a force is zero when:
(i) there is no displacement, and
(ii) the displacement is normal to the direction of the force.

184. State two conditions when work done by a force is zero.

Ans : COMP 2014

Work done is given by the expression $\text{W} = \text{FS}\cos\theta$

Downloaded from www.pdf.tube

. Work done is zero, if :
(i) displacement is zero or (ii) force and displacement are perpendicular to each other.

185. What should be the angle between force and displacement to get the work:
(a) maximum, (b) minimum?

Ans : SQP 2018

Work done $W = Fs\cos\theta$

(a) If $\theta = 0°$, *i.e.* the angle between the force F and the displacement s in the same direction is zero.

$$W = Fs\cos 0°$$

$$W = Fs$$

(b) If $0 = 90°$, *i.e.* the force under consideration is normal to the direction of motion.

$$W = Fs\cos 90° = 0$$

186. A body is acted upon by a force. State two conditions when the work done is zero.

Ans : MAIN 2019

Work done will be zero, if
(i) there is no displacement (S = 0).
(ii) the displacement is normal to the direction of force ($\theta = 90°$).

187. What is the work done by a coolie walking on a horizontal platform with a load on his head?

Ans : COMP 2020

In order to balance the load on his head, the coolie applies a force on it in the upward direction, equal to its weight. His displacement is along the horizontal direction. Thus, the angle between force F and displacement is 90°. Therefore, work done $W = \text{FS}\cos\theta = \text{FS}\cos 90° = 0$, since $\cos 90° = 0$.

188. Define a kilowatt hour. How is it related to the joule?

Ans : MAIN 2021

1 kWh is the amount of electric energy consumed in an electrical circuit when the electrical appliance of power 1 kW works for an hour.

$$1\text{ kW} = 1000\text{ W} \times 3600\ s$$

$$= 1000\frac{\text{J}}{\text{s}} \times 3600\ s$$

$$= 3.6\times10^6\text{J}$$

189. How can the work done be measured when force is applied at an angle to the direction of displacement?

Ans : SQP 2023

When force F is applied at angle θ to the direction of displacement d, then

$$W = Fd\cos\theta$$

190. Two bodies of masses m_1 and m_2 have the same linear momenta. What is the ratio of their kinetic energies ?

Ans : COMP 2005

If v_1 and v_2 are the velocities of two bodies of masses m_1 and m_2 respectively.

As $K = \frac{p^2}{2m}$

So for same p, $K \propto \frac{1}{m}$

$$\frac{K_1}{K_2} = \frac{\frac{1}{m_1}}{\frac{1}{m_2}} = \frac{m_2}{m_1}$$

191. How is work done related to the applied force?

Ans : SQP 2012

It is measured by the amount of work done by the body, it is related to the applied force by the following relation:
Work done (W) = applied force (F) × displacement in the direction of force (S).

192. By what factor does the kinetic energy of a moving body change when its speed is reduced to halt?

Ans : COMP 2018

Let a body of mass m is moving with speed v. After sometime speed changes to $v/2$, so

Initial kinetic energy $K_1 = \frac{1}{2}mv^2$

Final Kinetic energy $K_2 = \frac{1}{2}m\left(\frac{v}{2}\right)^2$

$$= \frac{1}{2}\left(\frac{mv^2}{4}\right)$$

$$= \frac{1}{4}\left(\frac{1}{2}mv^2\right) = \frac{1}{4}K_1$$

THREE MARKS QUESTIONS

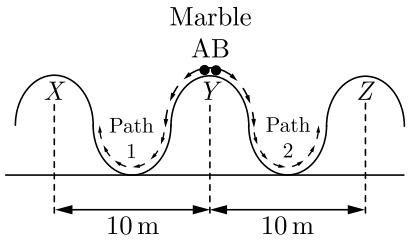
193. For each of the following scenarios, state whether the work done by gravity is positive, negative, or zero.

(a) a person walks on a levelled road.
(b) a person climbs a ladder.
(c) a car in neutral gear is coming down the slope.

Ans : SQP 2025

(a) No work is done.
(b) Negative work is done.
(c) Positive work is done.

194. Two identical marbles A and B are rolled down along Path 1 and Path 2 respectively. Path 1 is frictionless and Path 2 is rough.



(a) Which marble will surely reach the next peak?
(b) Along which path/s the mechanical energy will be conserved?
(c) Along which path/s is the law of conservation of energy obeyed?

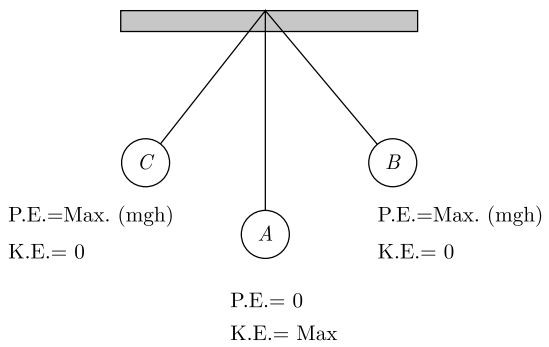
Ans : MAIN 2024

(a) Marble A
(b) Along both the paths.
(c) Along both the paths.

195. Draw a diagram to show the energy changes in an oscillating simple pendulum. Indicate in your diagram how the total mechanical energy in it remains constant during the oscillation.

Ans : COMP 2011

In the diagram A, B and C are different positions of the pendulum during oscillation.

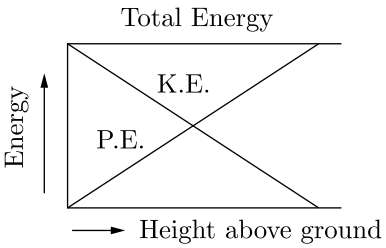


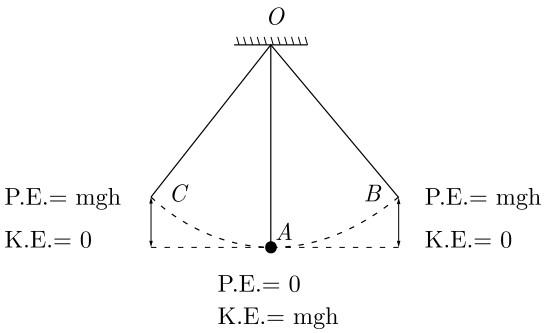
From the diagram it is clear that total mechanical energy, i.e. sum total of kinetic energy and potential energy, remains constant at different positions of oscillation respectively A, B and C.

196. Draw a diagram to show the energy changes in an oscillating simple pendulum. Indicate in your diagram how the total mechanical energy in it remains constant during the oscillation.

Ans : SQP 2011

The variation of potential and kinetic energy is as shown. The total energy remains constant.





197. In the following situations, mention if work is being done or not?
(i) A man pushing a wall.
(ii) A boy climbing a staircase.
(iii) A coolie standing with a heavy load on his head.

Ans : COMP 2012

(i) No work is done, as the displacement of the wall is zero.
(ii) Yes, work is done against gravity.
(iii) No work is done as the displacement is zero.

198. How is power related to force and velocity?

Ans : MAIN 2014

Rate of doing work is known as power.

$$\text{Power} = \frac{\text{Work}}{\text{Time}} \qquad ...(1)$$

Since, $\text{Work} = \text{Force} \times \text{Displacement}$

Now, equation (1) becomes

Click Here to Buy book on Amazon

$$\text{Power} = \frac{\text{Force} \times \text{Displacement}}{\text{Time}}$$

or $P = \vec{F} \times \frac{\vec{S}}{t}$

Since $\frac{\vec{S}}{t} = \text{Velocity} = \vec{V}$

Hence $P = \vec{F} \times \vec{V}$

Where, V is Average speed or Average velocity.

199. What kind of energy is possessed by a body in following cases?
(a) A moving bullet
(b) A spinning top
(c) A stone at rest at a certain height above the earth's surface

Ans : COMP 2010

(a) Kinetic Energy
(b) Kinetic Energy
(c) Potential Energy

200. A truck driver starts off with his loaded truck. What are the major energy changes that take place in setting the truck into motion?

Ans : SQP 2011

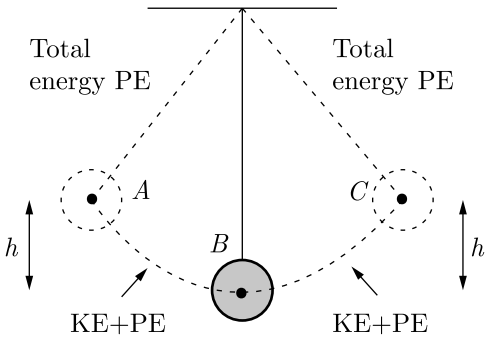
When truck is set into motion, following major energy changes take place:
(i) The battery in the truck engine, converts its chemical energy into electrical energy.
(ii) Electrical energy gets converted into mechanical energy and heat energy (electrical energy is used to move piston which in turn compresses (diesel + air) the mixture and heats it up).
(iii) Chemical energy of the fuel gets converted into heat energy and mechanical (kinetic) energy, i.e. the heated up fuel burns and expands and pushes the piston outwards which sets the wheels in motion.

201. State the principle of conservation of energy. Give one example to illustrate it.

Ans : MAIN 2020

The law of conservation of energy states that energy can neither be created nor destroyed but can be transformed from one form to another.
Simple pendulum : When a simple pendulum is displaced to one side and released, it swings from one side (extreme position) to the h other side (extreme position) reaching equal height h on either side (as shown in the figure). At the lowest point B, it has maximum kinetic energy; when it is at extreme positions (A and C) of the swing, it is momentarily at rest so it has no kinetic energy. Therefore, at these points (A and C) it has maximum potential energy. At intermediate positions between (A and B or B and C) it has both kinetic and potential energy, the sum of which remains constant.

NODIA



202. What do you understand by kinetic energy of a body? Give its SI unit. Also give two examples from everyday life.

Ans : COMP 2021

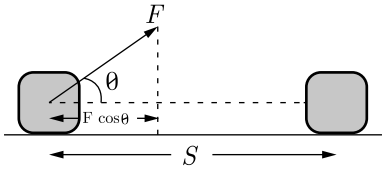
Kinetic energy of a body is the energy possessed by the body by virtue of its motion. If a body of mass (m) is moving with velocity (v), the kinetic energy $E_k = \frac{1}{2}mv^2$. The SI unit of energy is joule.

(i) A bullet fired from the gun is able to penetrate some distance into the target.
(ii) A falling stone can break a glass top of a table.

203. How do you measure the work when the force is applied at an angle?

Ans : SQP 2023

If the force is applied at an angle θ with the horizontal surface and the body is displaced along the surface, work done is the product of the component of the force ($F\cos\theta$) along the direction of the displacement and the displacement of the body, i.e.,



$$W = (F\cos\theta)\, s$$

$$W = Fs\cos\theta$$

204. Name the main energy transformations that occur in the following:
(a) An electric fan
(b) A filament lamp
(c) A steam engine

Ans : COMP 2016

(a)	An electric fan	-	electrical energy into mechanical energy
(b)	A filament lamp	-	electrical energy into light and heat energies
(c)	A steam engine	-	heat energy into mechanical energy

205. Name the main energy transformations that occur in the following:
(a) A photovoltaic cell (or photocell)
(b) A dynamo
(c) An electric motor

Ans : MAIN 2015

(a)	A photocell	-	light energy into electrical energy
(b)	A dynamo (or generator)	-	mechanical energy into electrical energy
(c)	An electric motor	-	electrical energy into mechanical energy

206. Name the main energy transformations that occur in the following:
(i) A loudspeaker
(ii) A microphone
(iii) A nuclear reactor

Ans : COMP 2010

(i)	A loudspeaker	-	electrical energy into sound energy and heat energy
(ii)	A microphone	-	sound energy into electrical energy
(iii)	A nuclear reactor	-	conversion of part of nuclear mass into heat energy

207. Name the main energy transformations that occur in the following:
(i) Photosynthesis
(ii) Burning of coal in thermoelectric stations
(iii) Striking a matchbox with a matchstick.

Ans : SQP 2009

(i)	Photosynthesis	-	light energy into chemical energy thermoelectric stations
(ii)	Burning of coal in thermoelectric stations	-	heat energy into electrical energy
(iii)	Striking a matchbox with a	-	chemical energy of the pasted chemicals into heat matchstick and light energy

208. Name the main energy transformations that occur in the following:
(i) A washing machine
(ii) An electric cell
(iii) An electromagnet

Ans : MAIN 2007

(i)	A washing machine	-	electrical energy into mechanical energy
(ii)	An electric cell	-	chemical energy into electrical energy
(iii)	An electromagnet	-	electrical energy into magnetic energy

209. Obtain the expression for kinetic energy of a body.

Ans : COMP 2008

Let a body having mass m initially at rest. On applying a force F, it covers a distance s through the acceleration a and its velocity becomes v in time t.
Work done by the force on the body, $W = Fs = mas$
But from third equation of motion, $v^2 = u^2 + 2as$

$$v^2 = 0 + 2as \qquad (\text{where } u = 0)$$

or $$= as\frac{v^2}{2}$$

$$W = \frac{m \times V^2}{2}$$

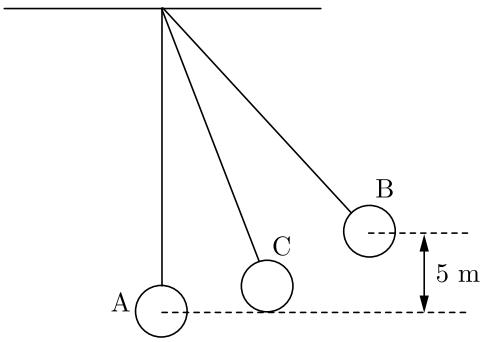
Here it may be noted that the work done W is stored in the form of kinetic energy of the body.

NODIA

$$E_k = \frac{1}{2}mv^2$$

FOUR MARKS QUESTIONS

210. The figure below shows a simple pendulum of mass 200 g. It is displaced from the mean position A to the extreme position B. The potential energy at the position A is zero. At the position B the pendulum bob is raised by 5 m.



(a) What is the potential energy of the pendulum at the position B?
(b) What is the total mechanical energy at point C?
(c) What is the speed of the bob at the position A when released from B?
(Take g = 10 ms^{-2} and given that there is no loss of energy.)

Ans : SQP 2025

(a) $U = mgh = 0.2 \times 10 \times 5 = 10\,J$
(b) 10 J [According to Pr. of conservation of energy]
(c) By principle of conservation of energy

$$U \text{ at the top} = K \text{ at the bottom}$$

$$10 = \frac{1}{2} \times 0.2 \times v^2$$

$$v^2 = 100$$

$$v = 10\,m\,s^{-1}$$

211. What happens to the kinetic energy when :
(i) the mass of the body is doubled at constant velocity?
(ii) the velocity of the body is doubled at constant mass?
(iii) the mass of the body is doubled but the velocity is reduced to half?

Ans : SQP 2015

The kinetic energy of a body of mass m and moving with velocity v is given by the expression $K = \frac{1}{2}mv^2$.

(i) Here, $m = 2m$ and $v = v$, therefore, final kinetic energy of the body will be $K_F = \frac{1}{2}2mv^2 = 2K$ i.e., the kinetic energy gets doubled.
(ii) Here, $m = m$ and $v = 2v$, therefore, final kinetic energy of the body will be $K_F = \frac{1}{2}m(2v)^2 = K$

i.e., the kinetic energy becomes four times the original.
(iii) Here, $m = 2m$ and $v = v/2$, therefore, final kinetic energy of the body will be $K_F = \frac{1}{2}2m(v/2)^2 = K/2$

i.e., the kinetic energy becomes half.

212. Justify giving proper reasoning whether the work done in the following cases is positive or negative :
(a) Work done by a man in lifting a bucket out of a well by means of a rope tied to the bucket.
(b) Work done by gravitational force in the above case.
(c) Work done by friction on a body sliding down an inclined plane.
(d) Work done by an applied force on a body moving on a rough horizontal plane with uniform velocity.

Ans : MAIN 2010

(a) Work done is positive as the bucket moves in the direction of force applied by the man.
(b) Work done by the gravitational force is negative, as the bucket moves upwards i.e., opposite to the gravitational force.
(c) Work done is negative, as frictional force acts opposite to the direction of motion of the body.
(d) Work done is positive because applied force acts along the same direction as the direction of motion of the body.

213. Energy can exist in several forms and may change from one form to another. For each of the following state the energy changes that occur in :
(a) the unwinding of a watch spring.
(b) a loaded truck when started and set in motion.
(c) a car going uphill.
(d) photosynthesis in green leaves.
(e) charging of a battery.

Ans : SQP 2020

Downloaded from www.pdf.tube

(a) Elastic potential energy into kinetic energy.
(b) Chemical energy of fuel into mechanical (kinetic) energy.
(c) Chemical energy of fuel into kinetic and then into potential energy.
(d) Solar energy (light energy) into chemical energy.
(e) Electrical energy to chemical energy.

214. A body of mass (m) is moving with a uniform velocity. A force is applied on the body due to which its velocity changes. How much work is being done by the force?

Ans : COMP 2010

Let the force act on the body through a distance change its velocity from u to v.
Let the force act for a time t.
Work done by the force = F × S

$$= ma \times \text{S} \qquad (\text{F} = ma)$$

$$= m\frac{(v-u)}{t} \times \text{S} \qquad \left(a = \frac{v-u}{t}\right)$$

But, $\frac{\text{S}}{t}$ = Average velocity

$$= \frac{v+u}{2}$$

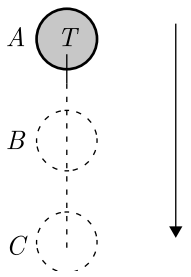
$$\text{Work done by the force} = m(v-u)\frac{(v+u)}{2}$$

$$= \frac{1}{2}m(v^2-u^2)$$

= Change in the kinetic energy

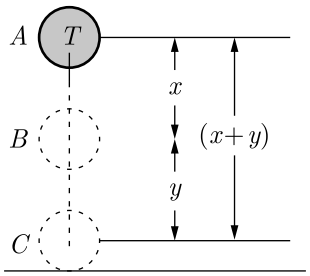
Which is also called the work energy principle.

215. An object of mass m is allowed to fall freely from point A as shown in the figure. Calculate the total mechanical energy of the object at:
(a) point A
(b) point B
(c) point C
(d) State the law which is verified by your calculations in parts (a), (b) and (c).



Ans : SQP 2016

Consider a body of mass m at a height $(x+y)$ from the earth's surface which falls freely under gravity, i.e. position A in figure.



Let us now calculate the sum of kinetic energy and potential energy at different positions say at A, B and C.
(a) At point A

$$\text{Kinetic energy} = 0 \ \{\text{since } u_A = 0 \text{ at } A\}$$

$$\text{Potential energy} = mg(x+y)$$

$$\text{Total energy} = KE + PE$$

$$= 0 + mg(x+y)$$

$$= mg(x+y) \qquad \ldots(1)$$

(b) At point B

$$\text{Kinetic energy} = \frac{1}{2}mv_B^2$$

From third equation of motion

$$v_B^2 = u_A^2 + 2gx$$

But, $u_A = 0$

$$v_B^2 = 0 + 2gx$$

$$\text{Kinetic energy} = \frac{1}{2}m \times 2gx = mgx$$

$$\text{Potential energy} = mgy$$

$$\text{So, total energy} = KE + PE = mgx + mgy$$

$$= mg(x+y) \qquad \ldots(2)$$

(c) At point C (on earth's surface)

$$\text{Kinetic energy} = \frac{1}{2}mv_C^2$$

From third equation of motion

$$v_C^2 = u_A^2 + 2g(x+y)$$

$$v_C^2 = 2g(x+y)$$

$$\text{Kinetic energy} = \frac{1}{2}m \times 2g(x+y)$$

$$= mg(x+y)$$

$$\text{Potential energy} = mg \times 0 = 0$$

$$\text{Total energy} = = KE + PE$$

$$= mg(x+y) + 0$$

$$= mg(x+y) \qquad \ldots(3)$$

Thus, it is clear from the equations (1), (2)

NODIA

and (3) that the total energy of the body always remains constant at each point of motion.

(d) **Law of conservation of energy:** According to law of conservation of energy, energy can neither be created nor destroyed. Energy can only be changed from one form to another. Thus, the total energy before and after the transformation always remains constant.

216. What is solar energy ? How is the solar energy used to generate electricity in a solar power plant?

Ans : COMP 2010

Solar energy is main source of renewable source of energy. All different forms of energies are directly or indirectly derived from the solar energy. Earth receives only 47% of the total solar energy that too in a diffused form.

A solar power plant consists of a number of concave reflectors at the focus of which there are black painted water pipes. The reflector concentrate the heat energy of sun rays on the pipes due to which water inside the pipes starts boiling and produces steam. The steam thus produced is used to rotate a steam turbine which drives a generator producing electricity.

NUMERICAL QUESTION

217. Sumit does 600 J of work in 10 min and Amit does 300 J of work in 20 min. Calculate the ratio of the powers delivered by them.

Ans : MAIN 2024

$$\text{Power of Sumit } P_{\text{Sumit}} = \frac{W_{\text{sumit}}}{t_{\text{sumit}}} = \frac{600}{10} = 60\,\text{W}$$

Similarly,

$$P_{\text{Amit}} = \frac{W_{\text{amit}}}{t_{\text{amit}}} = \frac{300}{20} = 15\ \text{W}$$

$$\text{P}_{\text{Sumit}}/\text{P}_{\text{Amit}} = \frac{60}{15} = \frac{4}{1}$$

218. A crane 'A' lifts a heavy load in 5 seconds, whereas another crane 'B' does the same work in 2 seconds. Compare the power of crane 'A' to that of crane 'B'.

Ans : COMP 2020

$$\text{Power, } P = \frac{W}{t}$$

Power is inversely proportional to time, thus from the expression,we have

$$\frac{P_A}{P_B} = \frac{t_B}{t_A}$$

$$= \frac{2}{5} = 0.4$$

219. Two bodies A and B have masses in the ratio 5 : 1 and their kinetic energies are in the ratio 125 : 9. Find the ratio of their velocities.

Ans : MAIN 2019

Given, $\frac{m_A}{m_B} = \frac{5}{1}$ and $\frac{K_A}{K_B} = \frac{125}{9}$

Kinetic energy $K = \frac{1}{2}mv^2$

Therefore, $\frac{v_A}{v_B} = \sqrt{\frac{K_A m_B}{K_B m_A}}$

$$= \sqrt{\frac{125}{9} \times \frac{1}{5}}$$

$$= \sqrt{\frac{25}{9}} = \frac{5}{3}$$

220. A body of mass 10 kg is kept at a height of 5 m. It is allowed to fall and reach the ground.

(i) What is the total mechanical energy possessed by the body at the height of 2 m assuming it is a frictionless medium?

(ii) What is the kinetic energy possessed by the body just before hitting the ground? Take $g = 10\,\text{m s}^{-2}$.

Ans : SQP 2019

(i) The total mechanical energy is the total potential energy it possesses before its fall.

$$E = mgh$$

$$= 10 \times 10 \times 5 = 500\,\text{J}$$

(ii) It is equal to the maximum potential energy

$$E = mgh$$

$$= 10 \times 10 \times 5 = 500\text{J}$$

221. If the power of a motor be 100 kW, at what speed can it raise a load of 50000 N ?

Ans : COMP 2017

$$\text{Power, } P = 100\,\text{kW}$$

$$F = 50000\,\text{N}$$

$$P = Fv,$$

$$v = P/F$$

$$= \frac{100000}{50000} = 2\,\text{m s}^{-1}$$

Click Here to Buy book on Amazon

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!

222. A body at rest is acted upon by a force F such that it acquires a speed v while moving with an acceleration a. Show that the work done by the force on the body is given by $\frac{1}{2}\left(\frac{F}{a}\right)v^2$.

Ans : COMP 2008

Initial velocity, $u = 0$,

Final speed $= v$,

Acceleration $= a$,

Force $= F$

$$\text{Work done} = F \times s\left(s = \frac{v^2 - u^2}{2a}\right)$$

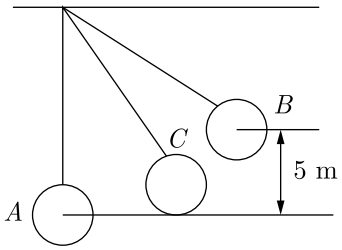
$$= F \times \frac{v^2 - u^2}{v^2 2a}$$

$$= F \times \frac{v^2}{2a} \qquad (\text{as } u = 0)$$

$$= \frac{Fv^2}{2a}$$

So, $$= \frac{1}{2}\left(\frac{F}{a}\right)v^2$$

223. The figure shows a simple pendulum of mass 200 g. It is displaced from the mean position A to the extreme position B. The potential energy at position A is zero. At the position B, the pendulum bob is raised by 5 m.



(i) What is the potential energy of the pendulum at position B?

(ii) What is the total mechanical energy at point C?

(iii) What is the speed of the bob at position A when released from B?

(Take g $= 10\ \text{m s}^{-2}$ and there is no loss of energy)

Ans : SQP 2020

(i) Potential energy at position B

$$P_B = mgh$$

$$= 0.2 \times 10 \times 5 = 10\text{J}$$

(ii) Total mechanical energy = potential energy at point B $= 10$ J

(iii) For position A

$$\frac{1}{2}mv^2 = mgh,$$

$$v = \sqrt{2gh}$$

$$= \sqrt{2 \times 10 \times 5} = 10\ \text{ms}^{-1}$$

224. A force is applied on a body of mass 20 kg moving with a velocity of 40 m s^{-1}. The body attains a velocity of 50 ms^{-1} in 2 seconds. Calculate the work done by the body.

Ans : MAIN 2013

Mass of the body, $m = 20$ kg

Initial velocity, $u = 40$ m s^{-1}

Final velocity, $v = 50$ m s^{-1}

Time, $t = 2$ s

Work done by the body = Change in kinetic energy

$$= \frac{1}{2}m(v^2 - u^2)$$

Work done by the body

$$= \frac{1}{2} \times 20 \times \left[(50)^2 - (40)^2\right]$$

Work done by the body

$$= 10\ [(50 - 40)(50 + 40)]$$

$$= 10 \times 10 \times 90 = 9000\ \text{J}$$

225. A moving body weighing 400 N possesses 500 J of kinetic energy. Calculate the velocity with which the body is moving. (Take $g = 10\ \text{ms}^{-2}$)

Ans : COMP 2012

Let the velocity of the moving body be v.

Mass of the moving body,

$$F = m \times a$$

$$m = \frac{400}{10} = 40\ \text{kg} = 10\ \text{ms}^{-2}$$

According to the law of conservation of energy

$$500 = \frac{1}{2} \times 40 \times v^2$$

$$v^2 = 25 = 5\ \text{m s}^{-1}$$

226. A body of mass 0.2 kg falls from a height of 10 m to a height of 6 m above the ground. Find the loss in potential energy taking place in the body. (Take g $= 10\text{m s}^{-2}$)

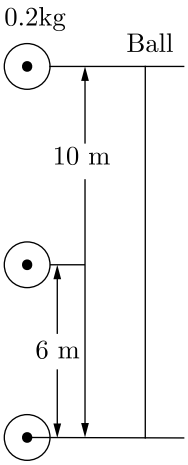
Ans : SQP 2012

Given, $m = 0.2$ kg

$h_1 = 10$ m

$h_2 = 6$ m

$g = 10\ \text{m s}^{-2}$



Loss in the potential energy $= mg\ (h_1 - h_2)$

$= 0.2 \times 10 \times (10 - 6)$

$= 8$ J

A bullet of mass 50 g is moving with a velocity of 500 ms^{-1}.

227. A ball of mass 200 g falls from a height of 5 m. What will be its kinetic energy when it just reaches the ground? (Take $g = 9.8\ ms^{-2}$)

Ans : COMP 2011

Potential energy of the ball,

$P.E. = mgh$

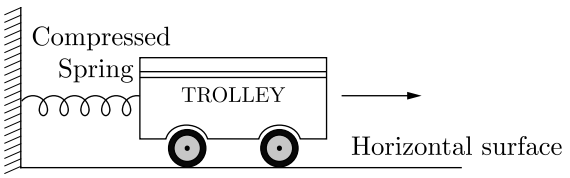
$= 0.2 \times 9.8 \times 5$

$= 9.8$ J

When the ball just reaches the ground, P.E. = K.E.

So, kinetic energy of the ball = 9.8 J.

228. A spring is kept compressed by a small trolley of mass 0.5 kg lying on a smooth horizontal surface as shown in the figure given:



When the trolley is released, it is found to move at a speed of 2 ms^{-1}. What potential energy did the spring possess when compressed?

Ans : SQP 2010

Potential energy = Kinetic energy of the of the spring when trolley compressed

$= \frac{1}{2} \times 0.5 \times (2)\ 2 = 1$ J

229. It penetrates 10 cm into a still target and comes to rest. Calculate :

(i) the K.E. possessed by the bullet.

(ii) the average retarding force offered by the target.

Ans : MAIN 2017

Given, $m = 50\ g = 50 \times 10^{-3}\ kg$,

$u = 500\ ms^{-1}$,

$S = 10\ cm$,

$v = 0\ ms^{-1}$,

K.E. = ?, F = ?

(i) $K.E. = \frac{1}{2}mv^2$

$= \frac{1}{2} \times 50 \times 10^{-3} \times (500)^2$

$= 6250$ J

(ii) To find retardation, we use the equation

$v^2 - u^2 = 2as$,

therefore, $a = \frac{v^2 - u^2}{2\ s}$

$= \frac{0^2 - (500)^2}{2 \times 10 \times 10^{-2}}$

$= -1250000\ ms^{-2}$

Therefore, retarding force is $F = m \times a$

$= 50 \times 10^{-3} \times 1250000$

$= 62500$ N

230. A body of mass 50 kg has a momentum of 3000 kg ms^{-1}. Calculate:

(a) the kinetic energy of the body,

(b) the velocity of the body.

Ans : COMP 2010

(a) Kinetic energy,

$E_k = \frac{P^2}{2m} = \frac{(3000)^2}{2 \times 50} = 90{,}000$ J

(b) Velocity of the body,

$v = \frac{p}{m} = \frac{3000}{50} = 60\ ms^{-1}$

231. A body of mass 5 kg is moving with a velocity of 10 ms^{-1}. What will be the ratio of its initial kinetic energy and final kinetic energy, if the mass of the body is doubled and its velocity is halved?

Ans : MAIN 2009

Initial mass = 5 kg

Final mass = 10 kg

Downloaded from www.pdf.tube

Initial velocity $= 10\ \text{ms}^1$

Final velocity $= 10/2 = 5\ \text{ms}^{-1}$

Initial kinetic energy $= \frac{1}{2}mv^2$

$= \frac{1}{2} \times 5 \times 10 \times 10$

$= 250\ \text{J}$

Final K.E. $= \frac{1}{2}mv^2$

$= \frac{1}{2} \times 10 \times 5 \times 5 = 125\ \text{J}$

So, ratio of initial to final K.E. $= \frac{250}{125} = 2:1$

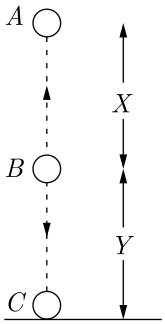
232. An object of mass 'm' is allowed to fall freely from point A as shown in the figure. Calculate the total mechanical energy of the object at :

(i) Point A

(ii) Point B

(iii) Point C

(iv) State the law which is verified by your calculations in parts (i), (ii) and (iii).



Ans : COMP 2009

(i) At point A : Total mechanical energy

$= mg(x+y)$

$=$ potential energy

(ii) At point B : Total mechanical energy is sum of kinetic and potential energy.

At point B,

P.E. $= mgy$ ...(1)

K.E. $= \frac{1}{2}mv^2$

$v^2 - u^2 = 2gx$

As $u = 0$ (during free fall)

Hence, $v^2 = 2gx$

K.E. $= \frac{1}{2}m \times 2gx = mgx$ ...(2)

Hence, P.E.+K.E. $= mgy + mgx = mg(y+x)$

(iii) At point C :

The body has only K.E., no P.E.

K.E. $= \frac{1}{2}mv^2$ and $v^2 = 2g(x+y)$

Hence, K.E. $= \frac{1}{2}m \times 2g(x+y)$

$= mg(x+y)$ ...(3)

(iv) The law which is verified in parts (i), (ii) and (iii) is conservation of energy i.e., total energy remains conserved. It may change from one form to another.

233. (i) A stone of mass 64.0 g is thrown vertically upward from the ground with an initial speed of 20.0 ms^{-1}. The gravitational potential energy at the ground level is considered to be zero. Apply the principle of conservation of energy and calculate the potential energy at the maximum height attained by the stone. ($g = 10\ \text{ms}^{-2}$)

(ii) Using the same principle, state what will be the total energy of the body at its half-way point?

Ans : COMP 2008

(i) When a stone is thrown vertically upwards, kinetic energy of the stone gets converted into potential energy. By applying principle of conservation of energy,

Kinetic energy = Potential energy

So, at the top it will have potential energy which is calculated.

$m = \frac{64}{1000}\text{kg},\ u = 20\ \text{ms}^{-1}$

So, kinetic energy $= \frac{1}{2}mu^2$

$= \frac{1}{2} \times \frac{64}{1000} \times 400$

$= 12.8\ \text{Joule}$

(ii) During half-way down the energy possessed will be half because height will be half and kinetic energy will be 6.4 joule and potential energy will be 6.4 joule so total amount of energy will be 12.8 joule only.

234. Two bodies A and B of equal mass are kept at a height of 20 m and 30 m respectively, calculate the ratio of their potential energies.

Ans : SQP 2005

P.E $= mgh$

$U_1 = mg \times 20$

Potential energy of the second mass

$U_2 = mg \times 30$

Hence, $\frac{U_1}{U_2} = \frac{mg \times 20}{mg \times 30} = \frac{2}{3}$

NODIA

235. The work done by the heart is 1 joule per beat. Calculate the power of the heart if it beats 72 times in one minute.

Ans : MAIN 2005

In one beat, work done by heart is 1 joule and in 72 beats work done will be 72 joules.

Power of the heart, $P = \frac{W}{t}$

$$= \frac{72\text{ J}}{1\text{ min}}$$

$$= \frac{72\text{ J}}{60\text{ s}} = 1.2\text{ W}$$

236. A ball of mass 0.20 kg is thrown vertically upwards with an initial velocity of 20 ms^{-1}. Calculate the maximum potential energy it gains as it goes up.

Ans : COMP 2004

Given, $m = 0.20$ kg, $v = 20\,ms^{-1}$, P.E. = ?

The maximum potential energy is equal to the maximum kinetic energy, therefore,

$$\text{K.E.} = \text{P.E.} = \frac{1}{2}mv^2$$

$$= \frac{1}{2} \times 0.20 \times (20)^2 = 40\text{ J}$$

237. A girl of mass 35 kg climbs up from the first floor of a building at a height 4 m above the ground to the third floor at a height 12 m above the ground. What will be the increase in her gravitational potential energy? $(g = 10\text{ m s}^{-2})$

Ans : SQP 2010

Mass of the girls, $m = 35$kg

Increase in gravitational potential energy is given by

$$= mg(h_2 - h_1)$$

$$= 35\text{ kg} \times 10\ ms^{-2} \times (12 - 4)\text{ m}$$

$$= 2850\text{ J}$$

238. A world weight lifting record is held by Sergei Didyk of USSR. He lifted 261 kg to a height of 2.3 m in 4 s. Find (a) the weight lifted by Didyk, (b) the work done by him, and (c) the power developed by him. (Take $g = 10\,ms^{-2}$)

Ans : MAIN 2015

Given, $m = 261$ kg; $s = 2.3$ m;

$t = 4$ s; Weight = ?; W = ?

(a) Weight $= mg = 261 \times 10$

$$= 2610\text{ N}$$

(b) Work done, $W = Fs = 2610 \times 2.3$

$$= 6003\text{ J}$$

(c) Power, $P = \frac{W}{t} = \frac{6003}{4}$

$$= 1500.75\text{ W}$$

239. A block and tackle of 5 pulleys is used to raise a load of 50 kg f steadily through a height of 20 m. The work done against friction is 2000 J. Calculate:

(a) the work done by the effort

(b) the efficiency of the system

(c) mechanical advantage.

Ans : COMP 2017

Given, $L = 50$ kg $f = 50 \times 10 = 500$ N,

$d_L = 20$ m; $W_f = 2000$ J;

n = 5; = ?;

(a) Work done by the effort,
$W_E =$ Work done (in raising the load + against friction) $= 500 \times 20 + 200 = 12000$ J

(b) $$\eta = \frac{\text{Work done in raising the load}}{\text{Total work done by the effort}}$$

$$= \frac{10000\text{ J}}{12000\text{ J}}$$

$$= 0.833 = 83.3\%$$

(c) Work done by the effort, $W_E = E \times d_E$

$$12000\text{ J} = E \times 100\text{ m}$$

$$[d_E = 5d_L = 5 \times 20\text{ m} = 100\text{ m}]$$

$$E = 120\text{ N}$$

$$\text{MA} = \frac{500\text{ N}}{120\text{ N}} = 4.17$$

240. A person is holding a bucket by applying a vertical force of 10 N. He moves a horizontal distance of 5m and then climbs up a vertical distance of 10 m. Calculate the total work done by him.

Ans : SQP 2018

Because the person first moves a horizontal distance of 5 m. Hence, for this part of motion, the angle between the force and displacement is 90°.

Hence, the work done is given by

$$W_1 = FS\cos\theta$$

$$= 10 \times 5\cos 90^\circ$$

$$= (10)(5)(0) = 0$$

Click Here to Buy book on Amazon

For the vertical motion, the angle between the force and the displacement is 0°. Therefore, the work done is given by

$$W_2 = FS\cos 0^\circ$$
$$= (10)(10)(\cos 0^\circ)$$
$$= (10)(10)(1)$$
$$= 100\,\text{Nm} = 100\,\text{J}$$

Hence, total work done

$$= W_1 + W_2$$
$$= 0 + 100 = 100\,\text{J}$$

241. Calculate the kinetic energy of a body of mass 2 kg moving with a velocity of $0.1\,\text{ms}^{-1}$.

Ans : COMP 2019

Given,

$$\text{Mass, } m = 2\,\text{kg},$$
$$\text{Velocity, } v = 0.1\,\text{ms}^{-1}$$
$$\text{K.E. of a body} = \frac{1}{2}mv^2$$
$$\text{K.E.} = \frac{1}{2} \times 2 \times 0.1 \times 0.1$$
$$= 0.01\,\text{J}$$

242. A spring is kept compressed by a small trolley of mass 500 g lying on a smooth horizontal surface. When the trolley is released, it is found to move with a speed of 2 ms^{-1}. What potential energy did the spring possess when compressed ?

Ans : SQP 2021

According to law of conservation of energy,
Potential energy of spring = Kinetic energy gained by trolley

$$\text{K.E.} = \frac{1}{2}mv^2$$
$$= \frac{1}{2} \times 0.5 \times 2 \times 2$$
$$= 1 \text{ joule}$$

Hence, potential energy of spring = 1.0 J

243. How fast should a man weighing 60 kg run so that his kinetic energy is 750 J ?

Ans : COMP 2012

Given, $m = 60\,\text{kg},$

$\text{K.E.} = 750\,\text{J},\ v = ?$

Using $\text{K.E.} = \frac{1}{2}mv^2$, we have

$$v = \sqrt{\frac{2\text{K.E.}}{m}}$$
$$= \sqrt{\frac{2 \times 750}{60}}$$
$$= \sqrt{50} = 5\,\text{ms}^{-1}$$

244. An Ox can apply a maximum force of 1000 N. It is taking part in a cart race and is able to pull the cart at a constant speed of 30 ms^{-1} while making its best effort. Calculate the power developed by the Ox.

Ans : MAIN 2013

$$\text{Force, } F = 1000\text{ N},$$
$$\text{Velocity, } v = 30\ \text{ms}^{-1}$$
$$\text{Power developed} \quad P = F \times v$$
$$= 1000 \times 30$$
$$= \frac{1000 \times 30}{1000} = 30\,\text{KW}$$

245. A bullet of mass 25 g strikes a wooden target with a velocity of 100 ms^{-1} and emerges with a velocity of 20 ms^{-1}. Find the loss in energy during the process of penetration.

Ans : SQP 2016

$$\text{Mass of the bullet, } m = 25\text{g} = \frac{25}{1000}\text{kg}$$
$$\text{Velocity of the bullet, } v = 100\ \text{ms}^{-1}$$
$$\text{Initial K.E.} = \frac{1}{2}mv^2$$
$$= \frac{1}{2} \times \frac{25}{1000} \times 100 \times 100$$
$$= 125\,\text{J}$$
$$\text{Final K.E.} = \frac{1}{2} \times \frac{25}{1000} \times 20 \times 20$$
$$= 5\,\text{J}$$

Hence, loss of kinetic energy during penetration

$$= (125 - 5) = 120\,\text{J}$$

246. How much energy gets released when a mass of 1 g is converted completely into energy?
(Given, velocity of light $(c) = 3 \times 10^8\,\text{ms}^{-1}$.)

Ans : COMP 2017

Given, $\Delta m = 1\ g = 10^{-3}\,\text{kg}$

$c = 3 \times 10^8\,\text{ms}^{-1}$ (Velocity of light)

According to Einstein's mass energy relation

$$E = \Delta mc^2$$
$$= 10^{-3} \times (3 \times 10^8)^2$$

Downloaded from www.pdf.tube

$$= 9 \times 10^{16} \times 10^{-3}$$
$$= 9 \times 10^{13}\ \text{J}$$

247. Rajan exerts a force of 150 N in pulling a cart at a constant speed of 10 m/s. Calculate the power exerted.

Ans : COMP 2021

Given, $F = 150\ \text{N},\ v = 10\ \text{ms}^{-1}$,

Power, $P = Fv$

$= 150\ \text{N} \times 10\ \text{ms}^{-1}$

$= 1500\ \text{W}$

248. A boy of mass 40 kg runs up flight of 50 steps each 10 cm high in 5 second. Find :
(i) the work done by the boy.
(ii) the power developed. $(g = 9.8\ \text{ms}^{-2})$

Ans : SQP 2000

The boy has to overcome the force of gravity. Hence, force of gravity on the boy

$$F = mg = 40 \times 9.8 = 392\ \text{N}$$

Total distance covered

$$S = 50 \times 10$$
$$= 500\ \text{cm} = 5\ \text{m}$$

(i) Work done by the boy in climbing

$$\text{W} = \text{force} \times \text{distance}$$
$$\text{W} = 392 \times 5 = 1960\ \text{J}$$

(ii) Power developed $= \dfrac{\text{W}}{t} = \dfrac{1960}{5} = 392\ \text{W}$

249. Find the velocity of a body of mass 100 g having a kinetic energy of 20 J.

Ans : SQP 2019

Mass of the body, $m = 100\ \text{g} = 0.1\ \text{kg}$,

Kinetic energy $= 20\ \text{J}$,

Kinetic energy $= \dfrac{1}{2}mv^2$

Therefore, $v = \sqrt{\dfrac{2 \times \text{K.E.}}{m}}$

$= \sqrt{\dfrac{2 \times 20}{0.1}} = 20\ \text{ms}^{-1}$

250. Calculate the power of a pump which can lift 400 kg of water to store it in a water tank at a height of 19 m in 40 s. (Take g = 10 ms^{-2})

Ans : MAIN 2023

Given,

$m = 400\ \text{kg};\ g = 10\ \text{ms}^{-2}$;

$s = 19\ \text{m};\ t = 40\ \text{s}$;

$$P = \frac{W}{t} = \frac{Fs}{t} = \frac{mgs}{t}$$
$$P = \frac{400 \times 10 \times 19}{40}$$
$$P = 1900\ \text{W}$$

251. A man drops a 50 kg stone from the top of a ladder of length 10 m. What is its kinetic energy. When it reaches the ground? What is its speed just before it hits the ground? [Take $g = 9.8\ \text{ms}^{-2}$]

Ans : MAIN 2010

Mass of stone $= 50\ \text{kg}$

Length of ladder $= 10\ \text{m}$

Kinetic energy of the stone when it reaches the ground = Potential energy of the stone at the top of the ladder

$$= mgh = 50 \times 9.8 \times 10$$

Energy when it reaches the ground = 4900 J

Speed v of the stone just before hitting the ground

Initial velocity, $v = 0$

Height, $h = 10\ \text{m}$,

$g = 9.8\ \text{ms}^{-2}$

$v^2 - u^2 = 2gh$

$v^2 - 0 = 2gh$

$v = \sqrt{2gh}$

$= \sqrt{2 \times 9.8 \times 10}$

$= 14\ \text{ms}^{-1}$

252. A pump is used to lift 500 kg of water from a depth of 80 m in 10 s. Calculate :
(a) work done by the pump.
(b) the power at which the pump works.
(c) the power rating of the pump if its efficiency is 40%.

Ans : COMP 2009

Mass of water lifted $= 500\ \text{kg}$,

Depth of water $S = h = 80\ \text{m}$,

Time, $t = 10\ \text{s}$

(a) Work done by the pump

$= F \times S = mgh$

$= 500 \times 10 \times 80\ \text{J}$

$= 4 \times 10^5\ \text{J}$

NODIA

(b) Power at which it is working

$$= \frac{4 \times 10^5}{10} \text{ W}$$

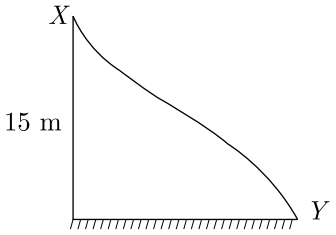
$$= 40 \text{ KW}$$

(c) $$\eta = \frac{\text{Useful Power}}{\text{Input Power}} \times 100$$

$$40 = \frac{40 \text{ KW} \times 100}{\text{Input Power}}$$

Hence, $$\text{Input Power} = \frac{40 \times 100}{40} = 100 \text{ KW}$$

253. A small block of mass 1 kg is released from seat at X which is at a height of 15 m from ground. The block comes down and reaches at Y travelling a curved path. Calculate the velocity of the block when it finally reaches Y.



Ans : SQP 2007

Height, $h = 15 \text{ m}$,

Mass of the block, $m = 1 \text{ kg}$

The loss in potential energy of the block in moving down

$$= mgh$$

$$= 1 \times 9.8 \times 15 = 147 \text{ J}$$

Gain in Kinetic energy on reaching Y

$$= \frac{1}{2}mv^2 = \frac{1}{2} \times 1 \times v^2$$

But K.E. = P.E.

$$\frac{1}{2} \times 1 \times v^2 = 147$$

$$v^2 = 294$$

Hence, $$v = 17.14 \text{ ms}^{-1}$$

254. A rocket of 3×10^6 kg mass takes off from a launching pad and acquires a vertical velocity of 1 kms^{-1} at an altitude of 25 km. Calculate (a) Potential energy, (b) Kinetic energy. (Take the value of $g = 10 \text{ ms}^{-2}$)

Ans : COMP 2011

Mass of rocket, $m = 3 \times 10^6 \text{ kg}$,

Height, $h = 25 \text{ km} = 25 \times 10^3 \text{ m}$

$g = 10 \text{ ms}^{-2}$

P.E. of the rocket $= mgh$

$$= 3 \times 10^6 \times 10 \times 25 \times 10^3$$

$$= 7.5 \times 10^{11} \text{J}$$

Now, K.E. of the rocket

$$= \frac{1}{2}mv^2$$

$$= \frac{1}{2} \times 3 \times 10^6 \times 10^3 \times 10^3$$

$$= 1.5 \times 10^{12} \text{J}$$

255. Two bodies of equal masses move with the uniform velocities v and $3v$ respectively. Find the ratio of their kinetic energies.

Ans : MAIN 2010

Let the mass of each body be m. Then, kinetic energy of the first body,

$$K_1 = \frac{1}{2}mv^2 \quad ...(1)$$

Kinetic energy of the second body,

$$K_2 = \frac{1}{2}mv^2$$

$$= \frac{1}{2}m(3v)^2 = \frac{9}{2}mv^2 \quad ...(2)$$

Dividing (2) by (1), we have

$$\frac{K_2}{K_1} = \frac{\frac{9}{2}mv^2}{\frac{1}{2}mv^2} = \frac{9}{1}$$

Thus, the kinetic energy of the second body is nine times the kinetic energy of the first body.

256. A body of mass 5 kg is moving with a velocity of 10 m s^{-1}. What will be the ratio of its initial kinetic energy and final kinetic energy, if the mass of the body is doubled and its velocity is halved?

Ans : SQP 2015

Given, $m_1 = 5 \text{ kg}$, $v_1 = 10 \text{ m s}^{-1}$,

$m_2 = 10 \text{ kg}$, $v_2 = 5 \text{ m s}^{-1}$

$$\frac{(KE)_{\text{intial}}}{(KE)_{\text{final}}} = \frac{\frac{1}{2} \times 5 \times (10)^2}{\frac{1}{2} \times 10 \times (5)^2} = \frac{2}{1}$$

$$= 2 : 1$$

257. A horse exerts a pull on a cart of 300 N so that horse cart system moves with a uniform speed of 18 km/h on a level road. Calculate the power developed by horse in watt and also find its equivalent in horse power.

Click Here to Buy book on Amazon

Ans : COMP 2018

$$\text{Force, } F = 300 \text{ N};$$

$$\text{Speed of car, } v = 18 \text{ km h}^{-1}$$

$$= \left(18 \times \frac{5}{18}\right) \text{m s}^{-1} = 5 \text{ m s}^{-1}$$

$$\text{Power, } P = Fv = 300 \times 5 = 1500 \text{ W}$$

Since, $1 \text{ hp} = 746 \text{ W}$

$$P = \frac{1500}{746} = 2\text{hp}$$

258. A body of mass 4 kg initially at rest is subjected to a force of 16 N. What is the kinetic energy acquired by the body at the end of 10 s?

Ans : MAIN 2021

Given, $m = 4 \text{ kg}, F = 16 \text{ N},$

$u = 0$, time, $t = 10 \text{ s}$

Now, acceleration, $a = \frac{F}{m}$

$$= \frac{16}{4} = 4 \text{ ms}^{-2}$$

Therefore, velocity v of the body after 10 s is given by

$$v = u + at$$

$$= 0 + 4 \times 10 = 40 \text{ ms}^{-1}$$

Hence, kinetic energy of the body at the end of 10 s

$$\text{K.E.} = \frac{1}{2}mv^2$$

$$= \frac{1}{2} \times 4 \times (40)^2 = 3200 \text{ J}$$

259. A boy pulls a toy car with a force of 50 N through a string which makes an angle of 30° with the horizontal, so as to move the toy by a distance of 1 m in the horizontal direction. If the string were inclined at an angle of 45° with the horizontal, how much pull would he apply along the string in order to move it through the same distance of 1 m ? (Given $\cos 30^\circ = 0.8667$, $\cos 45^\circ = 0.7071$)

Ans : MAIN 2009

Case (i) : When the force acts at an angle of 30° with the horizontal.

Force $(F) = 50 \, N,$

Angle $(\theta) = 30^\circ$ and Distance $(s) = 1 \text{ m}$

Therefore, work done in moving the toy car

$$W = FS \cos \theta$$

$$= 50 \times 1 \times \cos 30^\circ$$

$$= 50 \times 0.8667 = 43.33 \text{ J}$$

Case (ii) : When the force acts at an angle of 45° with the horizontal.

As the toy car moves through the same distance of 1 m, therefore, same work has to be done, even when force acts at an angle of 45°.

Given,Work done $(W) = 43.33 \text{ J},$

Angle $(\theta) = 45^\circ$, Distance $(S) = 1 \text{ m},$

Force $(F) = ?$

$$W = FS \cos \theta$$

$$F = \frac{W}{S \cos 45^\circ}$$

$$= \frac{43.33}{1 \times 0.7071} = 61.27 \text{ N}$$

260. A machine which is 75% efficient, uses 1.2 J of energy in lifting up a 2.0 kg mass through a certain distance. This mass is then allowed to fall through that distance. What will be its velocity at the end of its fall?

Ans : COMP 2023

$$\text{Efficiency} = \frac{\text{Useful work done}}{\text{Total work done}}$$

Hence, Useful work done

$$= \text{Total work done} \times \text{Efficiency}$$

$$= 12 \times 0.75 = 9.0 \text{ J}$$

When the mass is allowed to fall, the useful work gets converted into kinetic energy.

Hence, $\text{K.E.} = \frac{1}{2}mv^2$

$$9.0 = \frac{1}{2} \times 2 \times v^2$$

$$v^2 = 9$$

$$v = 3 \text{ ms}^{-1}$$

261. It takes 20 s for a person to climb up the stairs while another person B does the same in 15 s. Compare the (i) work done, (ii) power developed by the person A and B.

Ans : SQP2008

Since both A and B climb up the same stair case, both will do the same amount of work. If W_1 and $W_2$are the work done, then $\frac{W_1}{W_2} = \frac{1}{1}$

If P_1 and P_2 are the powers in the two cases, then

$$P_1 = \frac{W_1}{t_1}, \; P_2 = \frac{W_2}{t_2}$$

Hence, $\frac{P_1}{P_2} = \frac{W_1}{t_1} \times \frac{t_2}{W_2} = \frac{t_2}{t_1} \left(\frac{W_1}{W_2} = 1\right)$

NODIA

$$= \frac{15}{20} = \frac{3}{4}$$

Hence, $P_1 : P_2 :: 3 : 4$

262. 6.4 kJ of energy causes a displacement of 64 m in a body in the direction of force in 2.5 seconds. Calculate:
(a) the force applied
(b) power in horse power (hp). (Take 1 hp = 746 W)

Ans : COMP 2010

(a) Force applied, $F = \frac{6.4\text{ kJ}}{64\text{ m}}$

$$= \frac{(6.4\times10^3)\text{ J}}{64\text{ m}} = 100\text{ N}$$

(b) Power, $P = \frac{W}{t}$

$$= \frac{(6.4\times1000)\text{ J}}{2.5\text{ s}} = 2560\text{ W}$$

$$= \frac{2560}{746}\text{hp} = 3.4\text{ hp}$$

263. A body moves a distance of 5 m on a smooth horizontal surface under the influence of a force of 20 N. Calculate the work done by the force when
(a) the force acts along the horizontal surface and
(b) the force acts along a direction at an angle of 60° with the horizontal surface.

Ans : SQP 2015

(a) Given, $F = 20$ N; $s = 5$ m; $W = ?$
Work done by the force when it acts along the horizontal surface

$$W = Fs = 20 \times 5 = 100\text{ J}$$

(b) Angle between direction of force and displacement is 60^0; $W = ?$

$$W = Fs\cos\theta$$

$$= 20 \times 5 \times \cos 60^\circ$$

$$= 50\text{ J} \qquad \left(\cos 60^0 = \frac{1}{2}\right)$$

264. (a) A stone of mass 64.0 g is thrown vertically upward from the ground with an initial speed of 20.0 m/s. The gravitational potential energy at the ground level is considered to be zero. Apply the principle of conservation of energy and calculate the potential energy at the maximum height attained by the stone. (Take $g = 10\text{ ms}^{-2}$)
(b) Using the same principle, state what will be the total energy of the body at its half-way point?

Ans : MAIN 2018

(a) Potential energy at the maximum height will be the same as the kinetic energy be imparted from the ground.
Potential energy at the maximum height,

$$U = \frac{1}{2}mv^2$$

$$= \frac{1}{2}\times0.064 \times (20)^2 = 12.8\text{ J}$$

(b) According to law of conservation of energy, it remains same at every point. So at the midpoint energy = 12.8 J

265. A boy weighing 40 kgf climbs up a stair of 30 steps each 20 cm high in 4 minute and a girl weighing 30 kgf does the same in 3 minutes. Compare:
(a) The work done by them.
(b) The power developed by them.

Ans : COMP 2012

Mass of boy, $m_b = 40$ kgf

No. of steps = 30

$t = 4\text{ min} = 4\times60 = 240\text{ s}$

Height of each step = 20 cm

Total distance covered by boy,

$h_b = 30\times20 = 600\text{ cm} = 6\text{ m}$

Mass of girl, $m_g = 30$ kgf

Time taken by girl to climb 6 m = 3 min = 3× 60 s = 180 s

(a) Work done by boy in climbing up a stair of 30 steps

$$= m_b\times g\times h_b$$

$$= 40 \times 9.8 \times 6$$

$$= 2352\text{ J}$$

Work done by girl in climbing up a stair of 30 steps

$$= m_b\times g\times h_b$$

$$= 40 \times 9.8 \times 6$$

$$= 1764\text{ J}$$

Ratio of the work done by the boy : girl = 4:3

(b) Power developed by boy,

$$P_b = \frac{W_b}{t_b} = \frac{2352\text{ J}}{240\text{ s}} = 9.8\text{ W}$$

Power developed by boy to girl,

$$P_b = \frac{W_g}{t_g}$$

$$= \frac{1764\text{ J}}{180\text{ s}} = 9.8\text{ W}$$

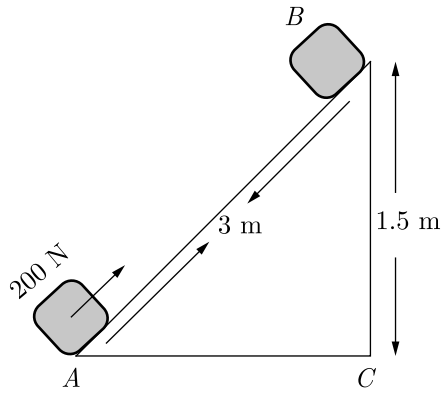
Power developed by boy to girl, 1 : 1

Downloaded from www.pdf.tube

266. A block of mass 30 kg is pulled up a slope (diagram below) with a constant speed by applying a force of 200 N parallel to the slope. A and B are initial and final positions of the block.

(i) Calculate the work done by the force in moving the block from A to B.

(ii) Calculate the potential energy gained by the block.



Ans : SQP 2015

Given, $m = 30\,\text{kg},\ F = 200\,\text{N},$

$AB = 3\,\text{m},\ CB = 1.5\,\text{m}$

(i) Work done is given by the product of force and displacement, therefore,

$$W = F \times S = F \times AB$$
$$= 200 \times 3 = 600\,\text{J}$$

(ii) Potential energy gained by the block

$$U = m \times g \times h$$
$$= 30 \times 10 \times 1.5 = 450\,\text{J}$$

267. A body of mass 10 kg falls from a height of 50 cm.

(a) Calculate :

(i) Velocity of the body.

(ii) Kinetic energy of the body when it just reaches the ground level.

(b) Does the velocity depend upon the mass of the body? Explain. (Take $g = 10\,\text{ms}^{-2}$)

Ans : COMP 2019

(a) (i) Initial velocity $(u) = 0$,

Final velocity $(v) = ?$,

Distance $(s) = h = 50\,\text{cm} = 0.5\,\text{m}$

Acceleration $(g) = 10\,\text{ms}^{-2}$

Using the equation of motion $v^2 - u^2 = 2gh$

$v^2 = u^2 + 2gh$, we have

$v^2 = 0 + 2 \times 10 \times 0.5 = 10$

$v = \sqrt{10} = 3.16\,\text{ms}^{-1}$

(ii) Kinetic energy of the body

$$= \frac{1}{2}mv^2 = \frac{1}{2} \times 10 \times 10 = 5\text{J}$$

In elevator

Work done $= fd\cos\theta = fd \times \cos 0^\circ = fd$

$$= mgd = 10 \times 10 \times \frac{1}{2} = 50\,\text{J}$$

Hence, work done in both the cases is same.

(b) Velocity of the body does not depend upon its mass, because the earth attracts all bodies with same acceleration due to gravity.

268. Calculate the amount of nuclear energy released when 1 g of matter is converted into energy. Take speed of light 3×10^8 ms^{-1}.

Ans : MAIN 2013

Given, $m = 1\,\text{g} = 1 \times 10^{-3}$ kg,

$c = 3 \times 10^8\,\text{ms}^{-1}$

$E = mc^2$

$= 1\times10^{-3}\times(3\times10^8)^2$

$= 9\times10^{13}$ J

269. Calculate the power of an engine required to lift 10^5 kg of coal per hour from a mine 360 m deep. [Take $g = 10\,\text{ms}^{-2}$]

Ans : SQP 2016

Given, $m = 10^5\,\text{kg},$

$g = 10\,\text{ms}^{-2},$

$h = 360\,\text{m},$

$t = 1\,\text{hour}$

$= 60 \times 60\,\text{s} = 3600\,\text{s}$

The work needed in lifting a mass m to a height h ,against the gravitational force, $\text{W} = mgh$

$$\text{Power, } P = \frac{\text{W}}{t}$$
$$= \frac{10^5 \times 10 \times 360}{3600}$$
$$= 10^5\,\text{W}$$

270. A boy weighing 350 N runs up a flight of 30 steps, each 20 cm high, in 5 seconds. Calculate the power expanded.

Ans : COMP 2011

Weight of the boy (mg) = 350 N

Total distance covered by the boy

NODIA

$= 30 \times 20$ cm

$= 600$ cm $= 6$ m

Power expanded by the boy

$$= \frac{\text{Work done}}{\text{Time taken}}$$

$$= \frac{350\ \text{N} \times 6\ \text{m}}{5\ \text{s}}$$

$= 420$ J/s or 420 W

271. An electric motor of power 100 W is used to drive the stirrer in a water bath. If 50% of the energy supplied to the motor is spent in stirring the water. Calculate the work done on the water in one minute.

Ans : SQP 2017

Power $= 100$ W

$t = 1$ minute $= 60$ second

Power consumed on stirring water $= 50\%$ of the power supplied.

Therefore,

Power consumed $\quad P = \frac{50}{100} \times 100 = 50$ W

Hence, $\quad$ Work done $=$ Power $\times$ Time

$= 50 \times 60 = 3000$ J

272. If the power of a motor is 40 kW, at what speed can it raise a load of 16000 N ?

Ans : COMP 2013

Power $=$ Force $\times$ Speed

$$\text{Speed} = \frac{40000}{16000} = 2.5\ \text{ms}^{-1}$$

273. Calculate the kinetic energy of a body of mass 0.1 kg and momentum 40 kg ms^{-1}.

Ans : SQP 2016

K.E. $= \frac{1}{2}mv^2$ and momentum $p = m \times v$

$$\text{K.E.} = \frac{1}{2}m \times \left(\frac{p}{m}\right)^2 \text{ or } \frac{p^2}{2m}$$

$$\text{Final energy} = \frac{40^2}{2 \times 0.1}$$

Hence, $\quad$ K.E. $= 8000$ J

274. Calculate the height through which a body of mass 0.5 kg should be lifted if the energy spent for doing so is 1.0 joule. (Take $g = 10$ m s^2)

Ans : MAIN 2017

Energy spent in lifting a body to a height h, $E =$ mgh

According to question,

$$1.0\ \text{J} = 0.5 \times 10 \times h$$

$$h = 0.2\ \text{m}$$

CASE BASED QUESTION

275. It has been predicted that in the future large offshore wind turbines may have a power output ten times that of the largest ones currently in use. These turbines could have a blade length of 100 m or more. A turbine such as this is shown in Figure.

At a wind speed of 11 ms^{-1} the volume of air passing through the blades each second is 3.5×10^{-5} m^3.

(i) Show that the mass of air that would pass through the blades each second is about 4×10^5 kg.
The density of air is 1.2 kg m^{-3}

(ii) Calculate the kinetic energy of the air that would enter the turbine each second.

(iii) It has been predicted that the turbine would produce an electrical power output of 10 MW in these wind conditions. Calculate the percentage efficiency of the turbine in converting this kinetic energy into electrical energy.

Ans :

(i) Mass of air, $m = \rho V$

$= 1.2 \times 3.5 \times 10^5$

$= 4.2 \times 10^5$ kg

(ii) $E_k = \frac{1}{2}mv^2$

$= \frac{1}{2} \times 4.2 \times 10^5 \times 11^2$

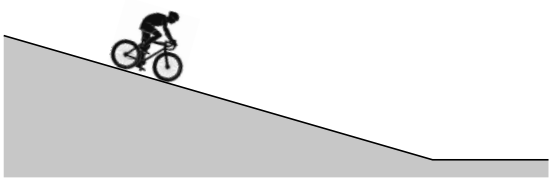
$= 2.5 \times 10^7$ J

Click Here to Buy book on Amazon

(iii) $\text{Percentage efficiency} = \frac{10 \times 10^6}{2.54 \times 10^7} \times 100$

$= 39.37 \approx 40\%$

276. A cyclist pedals downhill on a road, as shown in Figure, from rest at the top of the hill and reaches a horizontal section of the road at a speed of 16 ms^{-1}. The total mass of the cyclist and the cycle is 68 kg.



(i) Calculate the total kinetic energy of the cyclist and the cycle on reaching the horizontal section of the road.

(ii) The height difference between the top of the hill and the horizontal section of road is 12 m. Calculate the loss of gravitational potential energy of the cyclist and the cycle.

(iii) The work done by the cyclist when pedalling downhill is 2400 J. Account for the difference between the loss of gravitational potential energy and the gain of kinetic energy of the cyclist and the cycle.

Ans :

(i) $E_k = \frac{1}{2}mv^2$

$= 0.5 \times 68 \times 16^2$

$= 8704 \text{ J} \approx 8700 \text{ J}$

(ii) $\Delta E_p = mg\,\Delta h$

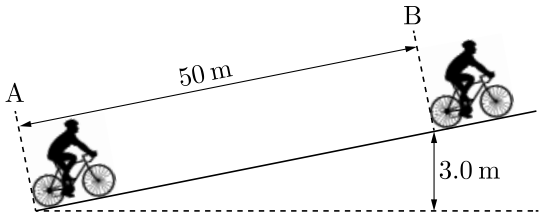
$= 68 \times 9.8(1) \times 12$

$= 7996.80 \text{ J} \approx 8000 \text{ J}$

(iii) $\text{KE} = \text{GPE} + \text{W} - \text{energy wasted}$

$\text{energy wasted} = 8000 + 2400 - 8700 = 1700 \text{ J}$

277. An 'E-bike' is bicycle that is assisted by an electric motor. Figure shows an E-bike and rider with a total mass of 83 kg moving up an incline.



(i) The cyclist begins at rest at A and accelerates uniformly to a speed of 6.7 m s^{-1} at B The distance between A and B is 50 m. Calculate the time taken for the cyclist to travel this distance.

(ii) Calculate the kinetic energy of E-bike and rider when at B. Give your answer to an appropriate number of significant figures.

(iii) Calculate the gravitational potential energy gained by the E-bike and rider between A and B.

Ans :

(i) $s = \frac{1}{2}(u+v)t$

Here initial velocity u is zero.

$t = \frac{2s}{v}$

$= \frac{100}{6.7} \approx 15 \text{ s}$

(ii) $KE = \frac{1}{2}mv^2$

$= \frac{1}{2} \times 83 \times (6.7)^2$

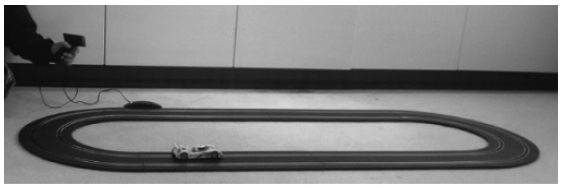
≈ 1900

(iii) $GPE = mgh$

$= 83 \times 9.81 \times 3.0$

$= 2442.69 \approx 2400$

278. The picture shows a track for racing toy electric cars. A guide pin fits in a groove in the track to keep the car on the track. A small electric motor in the car is controlled, with a hand-controller, via contacts in the track.



A child places a car of mass 95 g on the track. She adjusts the controller to a power of 4.2 W so the car accelerates from rest for 0.40 s.

(i) Show that the energy transferred by the motor in 0.40 s is about 2 J.

(ii) Calculate the speed of the car at 0.40 s.

(iii) Suggest why the actual speed of the car is less than the calculated speed.

Ans :

(i) $\text{Energy} = \text{power} \times \text{time}$

$= 4.2 \times 0.4$

NODIA

$$\text{Energy} = 1.6\text{J}$$

(ii) $$E_k = \frac{1}{2}mv^2$$

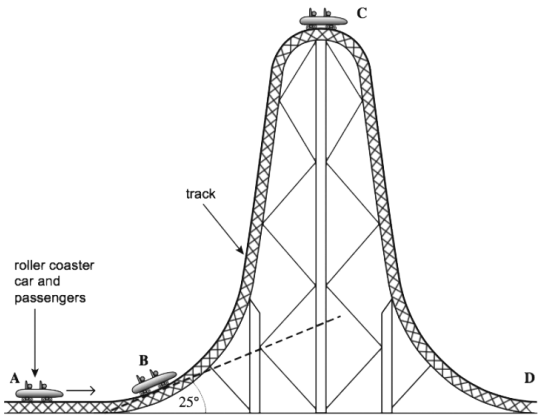
$$v = \sqrt{\frac{2E_k}{m}}$$

$$v = \sqrt{\frac{2 \times 1.68J}{0.095\,\text{kg}}}$$

$$v = 5.9\,\text{ms}^{-1}$$

(iii) The actual speed of the car is less than the calculated speed due to work done against friction.

279. Figure shows a roller coaster car which is accelerated from rest to a speed of 56ms^{-1} on a horizontal track, A, before ascending the steep part of the track. The roller coaster car then becomes stationary at C, the highest point of the track. The total mass of the car and passengers is 8300 kg.



(i) The angle of the track at B is 25° to the horizontal. Calculate the component of the weight of the car and passengers acting along the slope when the car and passengers are in position B as shown in Figure.

(ii) Calculate the kinetic energy of the car including the passengers when travelling at 56 ms^{-1}.

(iii) Calculate the maximum height above A that would be reached by the car and passengers if all the kinetic energy could be transferred to gravitational potential energy

Ans :

(i) $$w = mg\sin\theta$$

$$= 8300 \times 9.81 \sin 25$$

$$= 3.4 \times 10^4\text{N}$$

(ii) $$E_k = \frac{1}{2}mv^2$$

$$= \frac{1}{2} \times 8300 \times 56^2$$

$$= 1.3 \times 10^7\text{J}$$

(iii) $$K.E = mgh$$

$$h = \frac{KE}{mg}$$

$$= \frac{1.3 \times 10^7}{8300 \times 9.81}$$

$$= 159.66 \approx 160\text{m}$$

280. Figure shows a crater on the surface of the Earth.

The crater was formed by a meteor impact about 50,000 years ago. The meteor was estimated to have a mass of 3.0×10^8 kg with an initial kinetic energy of $8.4 \times 10^{16}\,J$ just before impact.

(i) State one major energy transformation that took place during the impact of the meteor with the Earth.

(ii) Show that the initial impact speed of the meteor was about 2.0×10^4 ms^{-1}.

(iii) The crater is about 200 m deep. Estimate the average force acting on the meteor during the impact.

Ans :

(i) Kinetic energy → heat

(ii) $$E = \frac{1}{2}mv^2$$

$$8.4 \times 10^{16} = \frac{1}{2} \times 3.0 \times 10^8 \times v^2$$

$$v^2 = \frac{2 \times 8.4 \times 10^{16}}{3.0 \times 10^8}$$

$$v = \sqrt{\frac{2 \times 8.4 \times 10^{16}}{3.0 \times 10^8}}$$

$$= 2.37 \times 10^4\,\text{ms}^{-1}$$

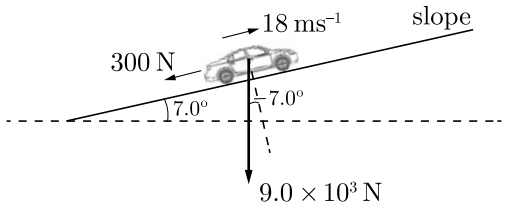
(iii) $$8.4 \times 10^{16} = F \times 200$$

$$F = \frac{8.4 \times 10^{16}}{200}$$

$$\text{Force} = 4.2 \times 10^{14}(\text{N})$$

NODIA

281. Figure shows a car traveling up a slope at a constant speed.



The angle between the slope and the horizontal is 7.0°. The weight of the car is 9.0 × 10^3 N. The car travels up the slope at a constant speed of 18ms^{-1}. A resistive force of 300 N acts on the car down the slope.

(i) What is the net force acting on the car? Explain your answer.

(ii) Calculate the component of the weight of the car acting down the slope.

(iii) Calculate the work done per second against the resistive force.

Ans :

(i) The car is moving with constant speed therefore acceleration is zero. Hence the speed is zero .hence net force is zero.

(ii) Component of weight $= w\cos\theta$

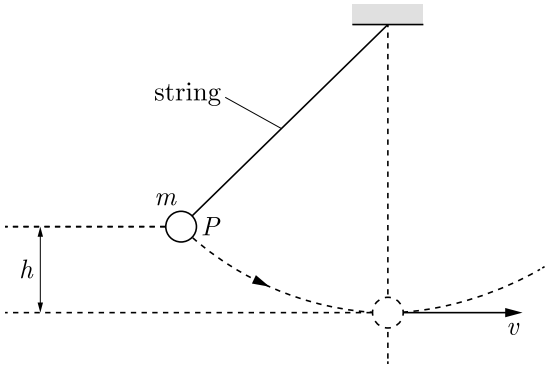
$= 9.1 \times 10^3 \cos 83^\circ$

$= 1.1 \times 10^3 \text{N}$

(iii) Work done per second $= 300 \times 18$

$= 5400\,(\text{J s}^{-1})$

282. Figure shows a simple pendulum with a metal ball attached to the end of a string.



When the ball is released from P, it describes a circular path. The ball has a maximum speed v at the bottom of its swing. The vertical distance between P and bottom of the swing is h. The mass of the ball is m.

(i) Write the equations for the change in gravitional potential energy, E_p, of the ball as it drops through the height h and for the kinetic energy, E_k, of the ball at the bottom of its swing when travelling at speed v.

(ii) Use the principle of conservation of energy derive an equation for the speed v. Assume that there are no energy losses due to air resistance.

Ans :

(i) $E_p = mgh$ and

$= \frac{1}{2}mv^2$

(ii) $mgh = \frac{1}{2}mv^2$

$v^2 = 2gh$ or $v = \sqrt{2gh}$

283. Some countries in the world have frequent thunderstorms. A group of scientists plan to use the energy from the falling rain to generate electricity. A typical thunderstorm deposits rain to a depth of 1.2 × 10^{-2} m over a surface area of 2.0 × 10^7 m^2 during a time of 900 s. The rain falls from an average height of 2.5 × 10^3m. The density of rainwater is 1.0 × 10^3kg m^{-3}. About 30% of the gravitational potential energy of the rain can be converted into electrical energy at the ground.

(i) Show that the total mass of water deposited in 900 s is 2.4 × 10^8 kg.

(ii) Hence show that the average electrical power available from this thunderstorm is about 2 GW.

Ans :

(i) $m = \rho V$

$= 1.0 \times 10^3 \times 1.2 \times 10^{-2} \times 2.0 \times 10^7$

$= 2.4 \times 10^8$ kg

(ii) loss in potential energy

$= 2.4 \times 10^8 \times 9.81 \times 2.5 \times 10^3$

$= 5.89 \times 10^{12}\,\text{J}$

30% of GPE $= 0.3 \times 5.89 \times 10^{12}$

$= 1.77 \times 10^{12}\,\text{J}$

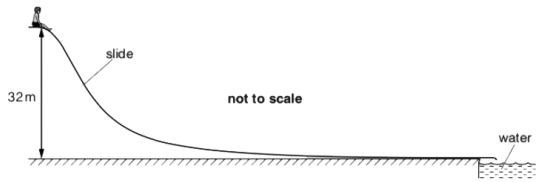
Power $= \frac{1.77 \times 10^{12}}{900}$

Power $= 1.9\,(63) \times 10^9\,(W)\,(\approx 2\,GW)$

FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

Downloaded from www.pdf.tube

284. Figure shows a water slide.



The top of the slide is 32 m above the bottom of the slide. The total distance along the slide is 120 m. A person of weight 700 N, initially at rest at the top, slides down. His speed at the end of the slide is 15 m s^{-1}.

(i) Calculate his kinetic energy at the end of the slide.

(ii) Calculate the average resistive force acting on him as he travels down to the end of the slide.

Ans :

(i) $w = mg$

$$\text{Mass, } m = \frac{700}{9.81} = 71.4 \text{ kg}$$

$$\text{Kinetic energy} = \frac{1}{2}mv^2$$

$$= \frac{1}{2} \times 71.4 \times 15^2$$

$$= 8.0 \times 10^3 (\text{J})$$

(ii) $\text{GPE} = mgh$

$$= 700 \times 32 = 2.24 \times 10^4 \text{J}$$

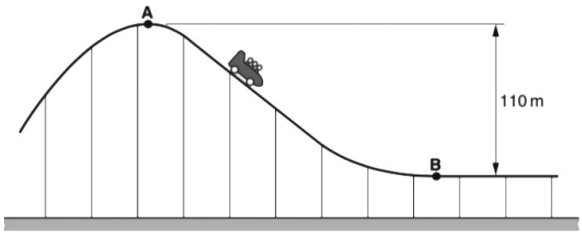
$$\text{Work done} = 2.24 \times 10^4 - 8.03 \times 10^3$$

$$= 1.44 \times 10^4$$

$$\text{Resistive force} = \frac{1.44 \times 10^4}{120}$$

$$\text{Resistive force} = 120 \,(\text{N})$$

285. Figure shows a side view of a roller coaster.



The carriage and its passengers start at rest at A. At B, the bottom of the ride, the maximum speed of the carriage is 20 ms^{-1}. The vertical distance between A and B is 110 m. The length of the track between A and B is 510 m. The mass of the carriage and the passengers is 4000 kg.

(i) Complete the sentence below.
In your answer, you should use appropriate technical terms, spelled correctly.
As the carriage travels from A to B, ... energy is transferred to ..... energy and heat.

(ii) By considering this energy transfer from A to B, determine the average frictional force acting on the carriage and passengers between A and B.

Ans :

(i) gravitational potential kinetic

(ii) $\text{GPE} = mgh$

$$= 400 \times 9.81 \times 110$$

$$= 4.32 \times 10^6 \text{J}$$

$$KE = \frac{1}{2}mv^2$$

$$\text{KE} = \frac{1}{2} \times 4000 \times 20^2$$

$$= 8.0 \times 10^5 \text{ J}$$

Work done

$$= (4000 \times 9.81 \times 110) - \left(\frac{1}{2} \times 4000 \times 20^2\right)$$

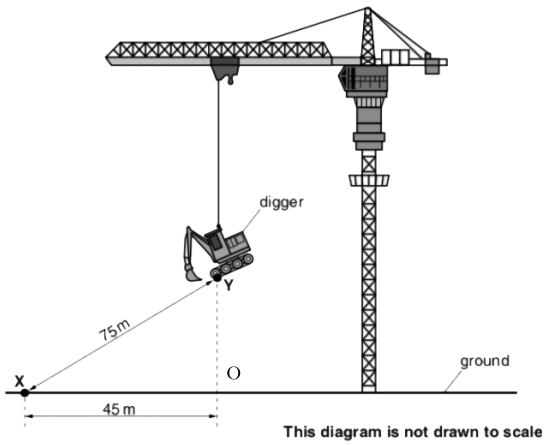
$$= 3.56 \times 10^6$$

$$\text{Work done} = \text{Force} \times \text{displacement}$$

$$\text{Force} = \frac{3.516 \times 10^6}{510}$$

$$= 6.89 \times 10^3 \approx 6.9 \times 10^3 \text{N}$$

286. Figure shows an electric crane lifting a mechanical digger.



The mass of the digger is 5200 kg. The crane takes 1.5 minutes to lift the digger from X to Y.

(i) Calculate the rate of work done to lift the digger from X to Y.

(ii) The total input power to the motors of the crane is 170 kW. Calculate the efficiency of the lifting operation.

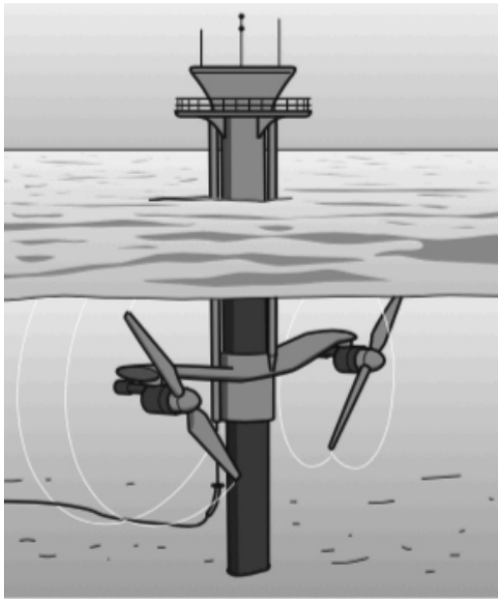
Ans :

(i) From $\triangle XOY$

$$\text{Vertical distance}, OY = (75^2 - 45^2)^{\frac{1}{2}}$$
$$= (3600)^{\frac{1}{2}}$$
$$= 60 \text{ m}$$
$$\text{Work done } mgh$$
$$= 5200 \times 9.81 \times 60$$
$$= 3.06 \times 10^6 \text{ J}$$
$$\text{Power} = \frac{\text{Work done}}{\text{time}}$$
$$= \frac{3.06 \times 10^6}{90}$$
$$\text{Power} = 3.4 \times 10^4 \text{ Js}^{-1}$$

(ii) $$\text{Efficiency} = \frac{34}{170} \times 100$$
$$= 20\%$$

287. Fossil fuels will eventually run out. This has led to scientists looking alternative sources of energy. Tidal stream systems use the kinetic energy of seawater to generate electrical energy during the incoming and outgoing tides. Figure shows a twin-turbine system in which flowing seawater turns the turbine blades.



When operating, 9.7×10^5 kg of seawater travelling at speed of $3.0\,\text{ms}^{-1}$ passes through each turbine every second. Each turbine generates 1.2×10^6 W of electrical power.

(i) Define power.

(ii) The input power to each turbine is the kinetic energy of the seawater that flows through each turbine in one second. Show that the input power to each turbine is 4.4×10^6 W.

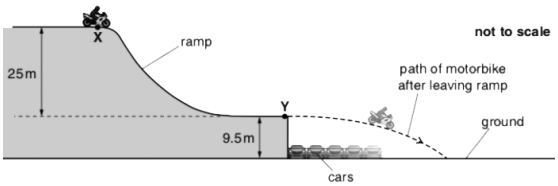
Ans :

(i) The rate of doing work is known as power.

(ii) $$\text{Power} = \text{KE / time}$$

Here, $$\text{Time} = 1 \text{ second}$$
$$\text{Power} = \text{KE}$$
$$= \frac{1}{2}mv^2$$
$$= \frac{1}{2} \times 9.7 \times 10^5 \times 3.0^2$$
$$= 4.365 \times 10^6 \text{ W}$$

288. Figure shows a stunt rider on a powerful motorbike at X at the top of a ramp.



The total mass of motorbike and rider is 190 kg. The height difference between the top and the bottom of the ramp is 25 m. The rider uses the engine to accelerate down the ramp. He leaves the end of the horizontal section of the ramp at Y with a speed of 30 m s^{-1}.

(i) Calculate the loss of gravitational potential energy E_p of the rider and motorbike from X to Y.

(ii) Calculate the kinetic energy E_k of the rider and motorbike at Y.

Ans :

(i) $$E_p = mgh$$
$$= 190 \times 9.81 \times 25$$
$$= 4.7 \times 10^4 \text{ (J)}$$

(ii) $$E_k = \frac{1}{2}mv^2$$
$$= \frac{1}{2} \times 190 \times 30^2$$
$$= 8.6 \times 10^4 \text{ J}$$

www.nodia.in

Click Here to Buy book on Amazon

CHAPTER 3

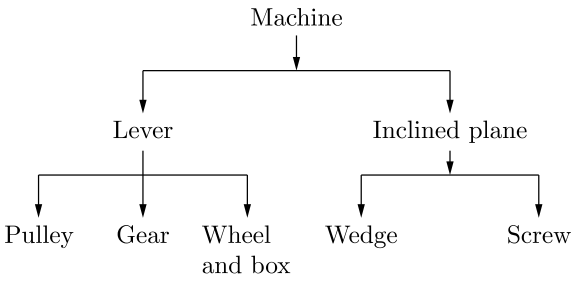
MECHANICS

SUMMARY

1. MACHINES

Machine is a device which acts as a force multiplier or speed multiplier allowing us to apply effort at a more convenient point in an easier direction.

Simple machines can be classified into two major classes, *i.e.* the lever and the inclined plane. But after modification into many other simple machines, the classification is of the following form:



(i) Load (L) is the resistance overcome by the machine.

(ii) Effort (E) is the force applied to overcome the resistance (or load).

1.1 Important Terms of Machine

Some important terms related to machine are as follows :

1. The mechanical advantage of a machine is the ratio of the load overcome to the effort applied, *i.e.*

$$\text{Mechanical Advantage } (MA) = \frac{\text{Load}(L)}{\text{Effort}(E)}$$

2. The velocity ratio of a machine is defined as the ratio of velocity of the effort to the velocity of the load.

$$\text{Velocity Ratio } (VR) = \frac{\text{Velocity of effort}(V_E)}{\text{Velocity of load}(V_L)}$$

3. If V_E, V_L are the velocities and d_E and d_L are the displacements of the effort and load respectively acting for a time t, then

$$VR = \frac{(d_E/t)}{(d_L/t)} = \frac{d_E}{d_L}$$

4. No machine works by itself. The work is to be done by the effort E on the machine which is called the work input. i.e.
W_i = effort $(E)\times$ displacement of the effort (d_E).

5. The work done by the machine in overcoming resistance or raising the load L is the work output. i.e.
W_o = load $(L)\times$ displacement of the load (d_L)

6. For an ideal (perfect) machine

$$\text{Work output } (W_O) = \text{Work input } (W_i)$$

or $$\text{Power output } (P_o) = \text{Power input } (P_t)$$

7. The efficiency of a machine is defined as the ratio of the useful work done by the machine to the total work put into the machine in a specific time.

$$\eta = \frac{\text{Outputpower}(P_o)}{\text{Inputpower}(P_t)}$$

$$\eta = \frac{\begin{matrix}\text{Use work done by machine}\\ \text{on load a certain time}(W_O)\end{matrix}}{\begin{matrix}\text{Total work put int o the machine}\\ \text{by effort in the same time}\,(W_t)\end{matrix}}$$

$$\eta = \frac{\text{Work output}(W_o)}{\text{Work input}(W_i)}$$

The efficiency of an ideal machine is 1 or 100%. But for an actual machine, it is always less than 100%.

8. Relation between efficiency (η), mechanical advantage (MA) and velocity ratio (VR)
Mechanical advantage

$$(MA) = \text{Velocity ratio } (VR)\times \text{Efficiency } (\eta)$$

2. LEVER

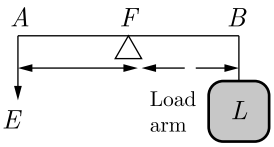
A lever is a rigid, straight or bent bar which is capable of turning about a fixed turning point called fulcrum.

According to principle of lever

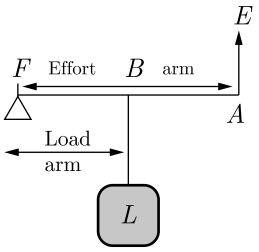
$$\text{Load} \times \text{Load arm} = \text{Effort} \times \text{Effort arm}$$

NODIA

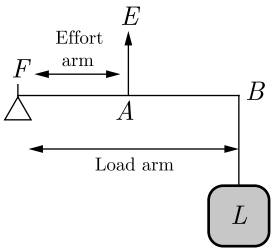
1. Depending upon the relative positions of the load, effort and fulcrum, levers are classified into three classes



Class 1 lever



Class 2 lever



Class 3 lever

2. Remember *FLE* for fulcrum F, load L and effort E in between for Class I, II and III levers respectively

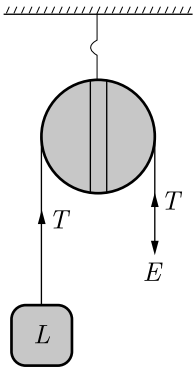
$$MA = \frac{\text{Effort arm}}{\text{Load arm}}$$

$$VR = \frac{\text{Effort arm}}{\text{Load arm}}$$

Remember :
For class I lever : Effort arm $>$, $=$ or $<$ Load arm and MA and VR may be, $>$, $=$ or < 1
For class II lever : Effort arm $>$ Load arm and MA and VR are always greater than one, hence act as a force multiplier
For class III lever : Effort arm is always $<$ Load arm, MA and VR are always less than one, hence act as a speed multiplier

3. PULLEY

Pulley is a grooved wheel which is free to rotate on an axle.
Single fixed pulley is used to change the direction of the force applied, *i.e.* the effort can be applied in a more convenient direction. For single fixed pulley (ideal condition).



Single fixed pully

$$MA = \frac{L}{E} = 1 \qquad \{L = E\}$$

$$VR = \frac{d_E}{d_L} = 1 \qquad \{d_E = d_L\}$$

$$\eta = \frac{MA}{VR} = 1 \text{ or } 100\%$$

However, if frictional forces (f) are not negligible,

$$L + f = T \text{ and } E = T,$$

$$MA = \frac{L}{E} = 1 - \frac{f}{E}$$

Since $VR = 1$, $\qquad \eta = \frac{MA}{VR} = 1 - \frac{f}{E}$

1. For a single movable (ideal) pulley

$$MA = VR = 2, = 1 \text{ or } 100\%$$

2. In a single movable pulley if W is the weight of the movable pulley, in equilibrium (as the system moves with uniform velocity.)

$$E = T \text{ and } L + w = 2T$$

$$MA = \frac{L}{E} = 2 - \frac{w}{E}$$

$$\eta = \frac{MA}{VR} = \frac{\left(2 - \frac{w}{E}\right)}{2}$$

$$= 1 - \frac{w}{2E} \backsimeq 1 - \frac{w}{L}$$

$$\{w << 2E \approx L\}$$

3.1 Combination of Movable Pulleys

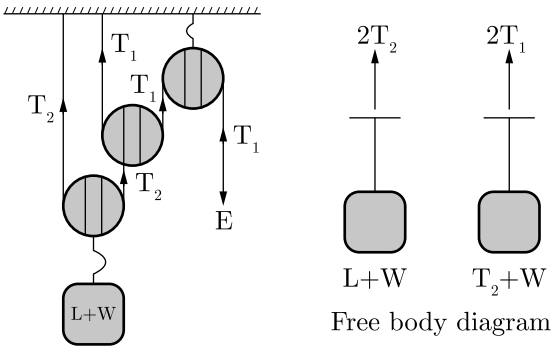
For ideal machine $E = T_1, L = 2T_2, T_2 = 2T_1$

$$MA = \frac{L}{E}$$

$$= \frac{2(2T_1)}{T_1} = 4$$

$$VR = 4$$

Downloaded from www.pdf.tube



Free body diagram

$$\eta = 1 \text{ or } 100\%$$

If weight of a single movable pulley is w,

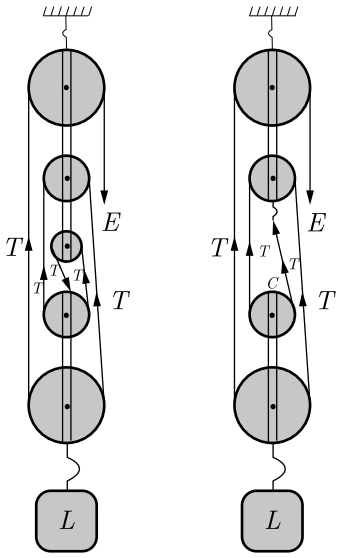
$$E = T_1\ , L + w = 2T_2,\ T_2 + W\ = 2T_1$$

$$MA = 4 - 3\frac{w}{E}$$

$$\eta = \frac{MA}{VR}\ = 1 - \frac{3w}{4E}$$

3.2 Block and Tackle System

In this system, two blocks of pulleys are used. The upper block is fixed and the lower block (tackle) is movable. The number of pulleys used in the movable lower block is either equal to or one less than the number of pulleys in the upper block. In this system if the number of pulleys (block + tackle) is even, the string starts on the hook attached to the block (upper frame). If the number of pulleys (block + tackle) is odd, the string starts on the hook attached to the tackle (lower frame) and the number of strings supporting the load and tackle is same as the total number of pulleys in the block and tackle.



Block and Tackle system

In general, if total number of pulleys used in block and tackle is n and effort is applied in downward direction,

$$E = T, L = nT$$

$$MA = \frac{nT}{T} = n$$

If load moves through a distance d, the effort moves through a distance nd

$$VR = \frac{d_E}{d_L} = \frac{nd}{d} = n$$

But if total weight of pulleys in the lower block be w,

$$L + w = nT, E = T$$

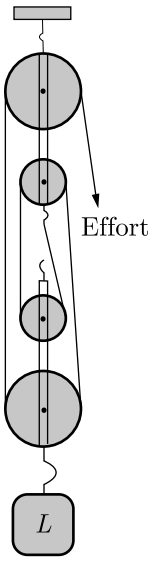
$$MA = n - \frac{w}{E}, VR = n$$

$$\eta = \frac{MA}{VR} = \left(\frac{n - \frac{w}{E}}{n}\right)$$

$$= 1 - \frac{w}{nE}$$

MULTIPLE CHOICE QUESTION

1. The given diagram shows the movable block of a block and tackle system with effort in a convenient direction. From the diagram we can conclude that the number of pulleys used in the fixed block are _____.



(a) 1 (b) 3
(c) 2 (d) 4

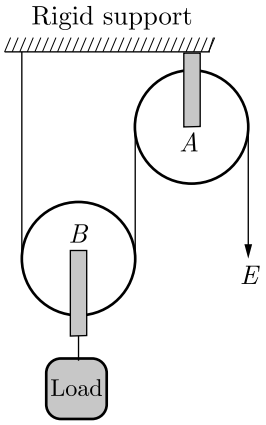
Ans :

SQP 2025

NODIA

The adjacent diagram shows the movable block of a block and tackle system with effort in a convenient direction. From the diagram we can conclude that the number of pulleys used in the fixed block are 2.
Thus (c) is correct option.

2. In the diagram shown below, the velocity ratio of the arrangement is



(a) 1 (b) 2
(c) 3 (d) 0

Ans : SEM-I, 2021

$$\text{Velocity ratio} = \frac{d_E}{d_L}$$
$$= \frac{2d}{d} = 2$$

Thus (b) is correct option.

3. A single fixed pulley is used because
(a) it changes the direction of applied effort conveniently
(b) it multiplies speed
(c) it multiplies effort
(d) its efficiency is 100%

Ans : SEM-I, 2021

A single fixed pulley is used to lift load by changing the direction of the lifting force. Even though a single fixed pulley has no mechanical gain in that, the effort applied is greater than the load.
Thus (a) is correct option.

4. A villager uses a single fixed pulley while a person in urban areas uses the combination of single fixed and single movable pulley. Which out of the two are more effective?
(a) Single fixed and single movable
(b) Single fixed
(c) None of the above
(d) Both (a) and (b)

Ans : MAIN 2015

Thus (a) is correct option.

5. Mechanical advantage is ratio of .....
(a) effort to load
(b) useful effort to load
(c) useful load to useful effort
(d) load to effort

Ans : MAIN 2013

Mechanical advantage is the ratio of load to the effort.
Thus (d) is correct option.

6. A pulley is used to lift a load of 180 kgf by applying an effort of 90 kgf in the downward direction. Calculate the work done by the effort applied on the pulley.
(a) 24 J (b) 6 J
(c) 12 J (d) 2 J

Ans : MAIN 2008

$$\text{Load} = 180 \text{ kgf}$$
$$\text{Effort} = 90 \text{ kgf}$$
$$\text{Velocity ratio} = \frac{\text{displacement of effort}}{\text{displacement of load}}$$
$$= \frac{180}{90} = 2 \text{ J}$$

Thus (d) is correct option.

7. A woman draws water from a well using a fixed pully. The mass of the bucket and the water together is 10 kg. The force applied by the woman is 200 N. The mechanical advantage is (Take $g = 10$ m/s^2)
(a) 2 (b) 20
(c) 0.05 (d) 0.5

Ans : SEM-I, 2021

$$\text{Load} = \text{weight of water}$$
$$L = 10 \times 10 \text{ N} = 100 \text{ N}$$
$$\text{Effort} = \text{force applied}$$
$$E = 200 \text{ N}$$
Now, $$\text{MA} = \frac{\text{Load}}{\text{Effort}}$$
$$= \frac{100}{200} = 0.5$$

Thus (d) is correct option.

FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

Click Here to Buy book on Amazon

8. In block and tackle system of pulleys the velocity ratio is .....
(a) one less than total number of pulleys
(b) ratio of displacement of load to displacement of effort
(c) equal to number of pulleys
(d) none of the above

Ans : MAIN 2006

Thus (c) is correct option.

9. Which of the statement is not true for an actual machine?
(a) Output of machine is always less than input
(b) Its mechanical advantage is less than velocity ratio.
(c) Its mechanical advantage is greater than velocity ratio.
(d) Its efficiency is always less than 100%

Ans : MAIN 2006

Its mechanical advantage is greater than velocity ratio.
Thus (c) is correct option.

10. A lever which can have mechanical advantage either less than one or more than one depending upon the position of fulcrum is a lever of :
(a) Third order
(b) Second order
(c) First order
(d) none of these

Ans : MAIN 2004

Fulcrum situated between the effort and the load. In this case, the effort is applied on one side of the fulcrum and the load on the other side. For example: a crowbar, a see-saw, or a pair of scissors. Mechanical advantage can be greater than, less than, or equal to unity.
Thus (c) is correct option.

11. Velocity ratio being a pure ratio is a ..... quantity.
(a) vector (b) unit-less
(c) meaningful (d) smart

Ans : COMP 2005

Velocity ratio is also defined as the ratio of a distance through which driven part of the machine moves, to that which the driving part moves during the same time. It has no unit because it is ratio of two velocities.
Thus (b) is correct option.

12. Efficiency is defined as .....
(a) Mechanical advantage + velocity ratio
(b) Mechanical advantage – velocity ratio
(c) Mechanical advantage / velocity ratio
(d) Mechanical advantage × velocity ratio.

Ans : MAIN 2015

Mechanical advantage is equal to the product of velocity ratio and efficiency. Therefore

$$\text{Efficiency} = \frac{\text{Mechanical advantage}}{\text{Velocity Ratio}}$$

For a machine of a given design, the velocity ratio does not change.
Thus (c) is correct option.

13. Mechanical advantage being a ..... ratio is an ..... quantity.
(a) pure, unit-less.
(b) impure, measurable.
(c) cute, impure.
(d) pure, irregular.

Ans : SQP 2018

Mechanical advantage is the ratio of load to the effort.
Here load and effort both are forces.
Thus (a) is correct option.

14. Increase in velocity ratio and mechanical advantage being constant would ..... the efficiency.
(a) increase (b) decrease
(c) not affect (d) none of these.

Ans : COMP 2022

$$\text{Efficiency} = \frac{\text{Mechanical advantage}}{\text{Velocity Ratio}}$$

The efficiency is the reciprocal of the velocity ratio. Thus, efficiency increases.
Thus (b) is correct option.

15. In a block and tackle system of pulleys the load is lifted through a height of 2 m while the effort is applied for 6 m. The velocity ratio of this system is
(a) 6 (b) 12
(c) 2 (d) 3

Ans : MAIN 2010

$$\text{VR} = \frac{V_E}{V_L} = \frac{d_E}{d_L}$$
$$= \frac{6}{2} = 3$$

Thus (d) is correct option.

Downloaded from www.pdf.tube

16. Efficiency is generally expressed as a .....
(a) percentage (b) decimal
(c) fraction (d) none of these

Ans : SQP 2005

Thus (b) is correct option.

17. Efficiency for a practical machine .....
(a) less than one (b) greater than one
(c) equal to one (d) not defined

Ans : MAIN 2007

Due to friction between the moving parts of the machine, the efficiency of the machine is less than 1.
Thus (a) is correct option.

18. Velocity ratio is also called ..... ratio.
(a) displacement (b) pure
(c) wonderful (d) design

Ans : SQP 2019

Since velocity is displacement / time and time for each displacement is same.
Thus (a) is correct option.

19. Load is .....
(a) resistive force to be overcome by machine
(b) exerted by machine
(c) external agency supplied to the machine
(d) none of the above

Ans : MAIN 2020

Thus (a) is correct option.

20. Effort is a .....
(a) external agency supplied to the machine
(b) created by the machine
(c) exerted on machine
(d) supplied by wind

Ans : SQP 2003

Thus (a) is correct option.

21. Decrease in mechanical advantage would ..... the efficiency.
(a) increase (b) not affect
(c) decrease (d) none of these

Ans : COMP 2002

Thus (c) is correct option.

22. Velocity ratio is the ratio of .....
(a) velocity of effort to velocity of load
(b) velocity of load to velocity of effort
(c) velocity of girl to velocity of boy
(d) none of the above

Ans : SQP 2006

Velocity ratio is the ratio of the velocity at which effort is applied on a machine to the velocity at which load moves.
Thus (a) is correct option.

23. A single fixed pulley is a modified form of .....
(a) Class III lever (b) Frisbee
(c) Class I lever (d) Class II lever

Ans : COMP 2021

A single class pulley is a modified form of class 2 lever. Second class lever or class two levers are the ones in which the load is located between fulcrum and the effort.
Thus (d) is correct option.

24. In even number of pulleys the string starts from the hook of ..... block.
(a) lower (b) upper
(c) both the (d) none of these

Ans : SQP 2016

Thus (b) is correct option.

25. In block and tackle system consisting of odd number of pulleys, the number of pulleys in the block is ..... more than number of pulleys in tackle.
(a) one (b) two
(c) three (d) four

Ans : SQP 2006

Thus (a) is correct option.

26. The size of pulleys ..... towards the load and ..... towards rigid support.
(a) increases, decreases
(b) decreases, increases
(c) decreases, decreases
(d) increases, increases

Ans : COMP 2013

Thus (d) is correct option.

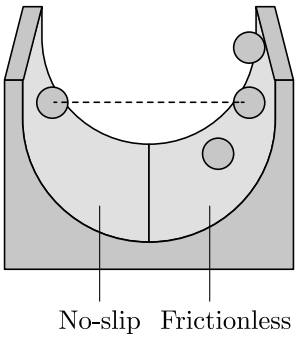
27. A pulley system consisting of four pulleys has efficiency as 90%. Calculate the Mechanical advantage of the system.
(a) 36 (b) 0.36
(c) 360 (d) 3.6

Ans : MAIN 2009

Work done by effort = Effort × Displacement of effort
Thus (d) is correct option.

NODIA

28. State the efficiency of the following system as shown in the figure:



(a) zero (b) infinite
(c) 1 (d) 100%

Ans : COMP 2019

Since frictionless no loss of energy.
Thus (d) is correct option.

29. The MA of a machine is 5 and its efficiency is 80%. It is used to lift a load of 200 kgf to a height of 20 m. What is the effort required ?
(a) 20 kgf (b) 10 kgf
(c) 50 kgf (d) 40 kgf

Ans : SQP 2022

$$\text{Efficiency} = 80\%$$
$$\text{Load} = 200 \text{ kgf}$$
$$= 200 \times 10 \text{ N}$$
$$\text{Mechanical advantage} = 5$$
$$MA = \frac{\text{Load}}{\text{Effort}}$$
$$5 = \frac{200 \times 10}{E}$$
$$E = \frac{200 \times 10}{5}$$
$$= 400 \text{ N} = 40 \text{ kgf}$$

Thus (d) is correct option.

30. A block and tackle system has $VR = 5$. Rahul exerts a pull of 150 kgf. What is the maximum load he can raise with this pulley system if its efficiency = 75% ?
(a) 661.5 (b) 332.4
(c) 500.2 (d) 562.5

Ans : MAIN 2020

$$\text{Velocity ratio} = \frac{\text{distance travelled by effort}}{\text{distance travelled by load}}$$
$$\text{Efficiency} = \frac{MA}{VR}$$
$$= \frac{\text{Mechanical advantage}}{\text{Velocity ratio}}$$
$$VR = 5,$$
$$\text{efficiency} = 75\%$$
$$\frac{75}{100} = \frac{MA}{5}$$
$$MA = 5 \times \frac{75}{100}$$
$$MA = \frac{\text{load}}{\text{effort}}$$
$$= \frac{L}{150 \text{ kgf}}$$
$$L = 5 \times \frac{75}{100} \times 150$$
$$= \frac{1125}{2} = 562.5$$

Thus (d) is correct option.

31. A sheaf pulley system has :
(a) multiplies speed
(b) multiplies effort
(c) efficiency more than 100%
(d) Both (a) and (b)

Ans : SQP 2011

Thus (b) is correct option.

32. Jibs, cranes and hoist are examples of .....
(a) sophisticated machines
(b) block and tackle system
(c) complex machines
(d) robotic machines

Ans : COMP 2000

Thus (b) is correct option.

33. A women draws water from a well using a fixed pulley. The mass of the bucket and water together is 6 kg. The force applied by the women is 70 N. The mechanical advantage is
(a) 0.86 (b) 0.96
(c) 0.66 (d) 0.76

Ans : COMP 2005

The mechanical advantage of a fixed pulley
$$= \frac{\text{Load}\,(L)}{\text{Effort}\,(E)}$$
Effort (force applied), $E = 70$ N
$$\text{Weight of the bucket} = mg = 6 \times 9.8$$
$$= 60 \text{ N}$$
$$\text{Hence, mechanical advantage} = \frac{60}{70} = 0.86$$

Thus (a) is correct option.

Click Here to Buy book on Amazon

34. What is the ratio of load to effort in case of a tree house elevator shown in the diagram below?

(b) 2 : 1 (b) 1 : 1
(c) 1 : 2 (d) none of the above

Ans : COMP 2001

Tree house elevator is using single fixed pulley so ratio of load to effort is 1 : 1
Thus (b) is correct option.

35. Name the pulley system used in the following application of lifting scrap from a junk yard:

(a) Block and tackle system of pulleys.
(b) Single fixed pulley.
(c) Combination of single fixed and single movable pulley.
(d) Single movable pulley.

Ans : MAIN 2012

Crane is an example of block and tackle for greater MA.
Thus (a) is correct option.

36. A person standing vertically upon his toes is an example of lever of :
(a) Second order (b) First order
(c) Third order (d) none of these

Ans : SQP 2020

Thus (c) is correct option.

37. A door is 1 in wide. It can be closed by an effort of 25 N, when effort is applied at a distance of 0.4 m from the hinge. What effort is needed, if it is applied at its extreme end ?
(a) 40 N (b) 80 N
(c) 10 N (d) 5 N

Ans : COMP 2002

$$E \times \text{Effort arm} = 25 \text{ N} \times 0.4 \text{ m}$$

Since, work done in both cases is same

Now, Effort $E_N \times 1 \text{ m} = 10$

$$E = \frac{10}{1} = 10 \text{ N}$$

Thus (c) is correct option.

38. In operating a water pump, a resistance of 480 N is overcome by an effort of 72 N. If the distance of the fulcrum from the point where the resistance act is 0.2 m. Find the distance from the fulcrum where effort is applied.
(a) 1.5 m (b) 2.58 m
(c) 0.8 m (d) 1.33 m

Ans : SQP 2011

$$\text{Load} = \text{resistance} = 480 \text{ N}$$

$$\text{Effort } E = 72 \text{ N}$$

$$\text{Load arm} = 0.2 \text{ m}$$

$$\text{Effort} \times \text{Effort arm} = \text{Load} \times \text{Load arm}$$

$$72 \times x = 480 \times 0.2$$

$$x = \frac{480}{72} \times \frac{2}{10}$$

$$= \frac{4}{5} = 1.33 \text{ m}$$

Thus (d) is correct option.

39. The handle of a nutcracker is 16 cm long and a nut is placed 2 cm from its hinge. If a force of 4 kgf is applied at the end of the handle to crack it, what weight, if simply, placed on the nut will crack it ?
(a) 15 kgf (b) 32 kgf
(c) 4 kgf (d) 9 kgf

Ans : COMP 2013

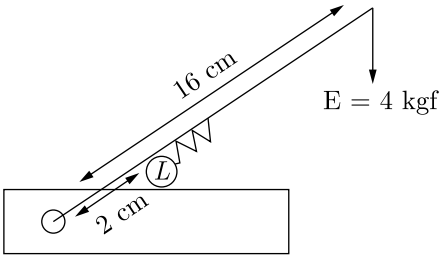
$$\text{Effort arm} = 16 \text{ cm} = \frac{16}{100} \text{ m}$$

$$\text{Effort } E = 4 \text{ kgf}$$

$$\text{Load arm} = 2 \text{ cm} = \frac{2}{100} \text{ m}$$

Suppose, $\text{Load} = L$

NODIA



$$L \times \text{load arm} = E \times \text{effort arm}$$

$$L \times \frac{2}{100} = 4 \times \frac{16}{100}$$

$$L = \frac{64}{100} \times \frac{100}{2}$$

$$= 32 \text{ kgf}$$

Thus (b) is correct option.

40. The actual mechanical advantage of a single movable pulley is :
(a) two
(b) less than 2, but more than 1
(c) one
(d) none of these

Ans : SQP 2007

Thus (b) is correct option.

41. A pulley system has a $VR = 5$. If the efficiency of the system is 80%, find its MA.
(a) 4 (b) 3
(c) 2 (d) 1

Ans : MAIN 2010

$$VR = 5, \text{ efficiency } = 80\%$$

$$\frac{MA}{VR} = \text{Efficiency}$$

$$80 = \frac{MA}{5}$$

$$MA = \frac{80}{100} \times 5 = 4$$

Thus (a) is correct option.

42. A single fixed pulley is used because :
(a) it multiplies effort
(b) it multiplies speed
(c) its efficiency is 100%
(d) it changes the direction of applied effort

Ans : SQP 2008

A single fixed pulley does not reduce the effort but helps in changing the direction of effort applied. As it is far easier to apply effort in a downward direction, the single fixed pulley is widely used.
Thus (d) is correct option.

43. What is the MA and VR of the machine shown in the figure below:

(a) MA = 2 and VR = 2
(b) MA = 2 and VR = 1
(c) MA = 1 and VR = 1
(d) MA = 1 and VR = 2

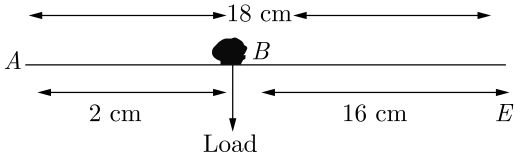
Ans : COMP 2003

The pulley used is single fixed hence MA and VR are 1.
Thus (c) is correct option.

44. A walnut can be broken by applying a direct force of 50 kgf. If the walnut is placed in a nut crackers, the length of whose handle is 18 cm and nut is placed 2 cm from the pivot, calculate the minimum force required to crack the nut.
(a) 9 kgf (b) 12 kgf
(c) 6.25 kgf (d) 7.50 kgf

Ans : MAIN 2002

Nut cracker is a lever of IInd order



$$\text{Effort arm } BE = 18 - 2 = 16 \text{ cm}$$

$$\text{Load arm } AB = 2 \text{ cm}$$

$$E = ?$$

$$L = 50 \text{ kgf}$$

Now, $$E \times 16 = 50 \times 2$$

$$E = \frac{100}{16} = 6.25 \text{ kgf}$$

Thus (c) is correct option.

Downloaded from www.pdf.tube

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!

45. A fulcrum divides a crow-bar in the ratio 3 : 1. What weight will be lifted if an effort of 100 N is applied at the end of its longer arm ?

(a) 400 N (b) 300 N
(c) 100 N (d) 500 N

Ans : COMP 2019

As, clockwise moment = anti-clockwise moment

Load × Load arm = Effort × Effort arm

Let load arm = x

effort = 100 N,

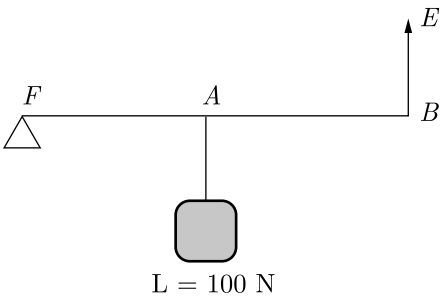
effort arm = $3x$

$3x \times 100 = x \times$ load

Hence, $\text{Load} = \frac{3x \times 100}{x} = 300$ N

Thus (b) is correct option.

46. If $FA = 40$ cm, $AB = 60$ cm, find MA of the lever.



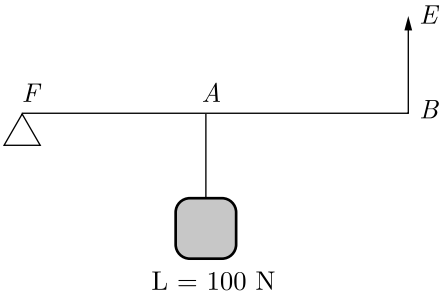
(b) 1.5 (b) 1
(c) 2.5 (d) 2

Ans : COMP 2020

Given, Load $L = 100$ N,

$FA = 40$ cm (load arm),

$AB = 60$ cm



Hence, $FB = FA + AB = 40 + 60$

$= 100$ cm (effort arm)

Load × Load arm = effort × effort arm

$100 \times 40 = E \times 100$

$E = 40$ N

Mechanical advantage $= \frac{\text{load}}{\text{effort}}$

$= \frac{100}{40} = 2.5$

Thus (c) is correct option.

47. A single movable pulley has :

(a) velocity ratio 2 and actual mechanical advantage 2
(b) velocity ratio 2 and actual mechanical advantage more than 2
(c) velocity ratio 2 and actual mechanical advantage less than 2
(d) none of the above

Ans : SQP 2023

Thus (c) is correct option.

48. A fire tong is a lever of :

(a) Third order (b) Second order
(c) First order (d) none of these

Ans : MAIN 2008

Fire tong has an effort arm in the middle, the load at one end, and the fulcrum at the other end. This type of arrangement is known as the Lever of the third order.
Thus (a) is correct option.

49. Which of the statement is not true for a machine?

(a) It can increase speed.
(b) It can change the direction of applied force.
(c) It can multiply force.
(d) Its output can be more than input.

Ans : COMP 2016

In practice, the work output of a machine is always less than the work input due to the effect of friction.
Thus (d) is correct option.

50. A boy uses a single movable pulley to lift a load of 50 kgf to some height. Another boy uses a single fixed pulley to lift the same load to same height. The ratio of efforts applied by them is

(a) $\frac{1}{2}$ (b) 4
(c) 2 (d) 1

Ans : MAIN 2004

Mechanical advantage (MA) given as,

$$MA = \frac{\text{Load}\,(L)}{\text{Effort}\,(E)}$$

NODIA

MA and efforts are inversely proportional to each other.
The MA of single fixed pulley $= 1$
For single movable pulley, $MA = 2$
Load on both the pulleys $= 50$ kgf
Effort for single fixed pulley

$$= \frac{\text{Load}}{MA}$$

$$= \frac{50}{1} = 50 \text{ kgf} \quad \text{...(i)}$$

Effort for single movable pulley

$$= \frac{\text{Load}}{MA}$$

$$= \frac{50}{2} = 2.5 \text{ kgf} \quad \text{...(ii)}$$

On dividing Eq. (i) by Eq. (ii), we get

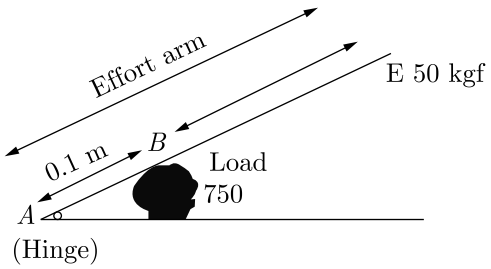
$$\frac{\text{Effort single fixed pulley}}{\text{Effort single movable pulley}} = \frac{50}{25} = \frac{2}{1}$$

Hence, $\frac{\text{effort single movable pulley}}{\text{effort single fixed pulley}} = \frac{1}{2}$

Thus (a) is correct option.

51. An effort of 50 kgf is applied at the end of a lever of the second order, which supports a load of 750 kgf, such that the load is at a distance of 0.1 m from the hinge. Find the length of the lever. (Assume that the lever is weightless)
(a) 0.1 m (b) 1.5 m
(c) 0.2 m (d) 0.8 m

Ans : SQP 2016



Length of lever = Effort arm $= AE$
Load arm $AB = 0.1$ m
Effort $E = 50$ kg-f
Load $L = 750$ kg-f
Hence, $AE \times 50 = 750 \times 0.1$

$$AE = \frac{750}{50} \times \frac{1}{10} = 1.5 \text{ m}$$

Thus (b) is correct option.

FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

52. What is the MA of the system of pulleys used in the below combination?

(a) 2 times the number of pulleys
(b) 2 / number of pulleys
(c) 2 number of movable pulleys
(d) 2 + number of pulleys

Ans : SQP 2011

Since ifs a combination of block and tackle the VR is dependent on number of movable pulleys
Thus (c) is correct option.

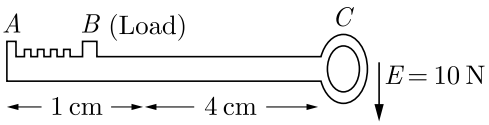
53. The correct relationship between the effort (E) load (L) and mechanical advantage ($M.A.$) is :
(a) $M.A. \times E = L$
(b) $M.A. = L \times E$
(c) $M.A. \times L = E$
(d) none of these

Ans : COMP 2006

Thus (a) is correct option.

54. A key is 5 cm long the turns the levers of a lock at a distance 1 cm. If the lock is opened by an effort of 10 N, calculate the resistance offered by the levers of the lock.
(a) 40 N (b) 80 N
(c) 20 N (d) 35 N

Ans : COMP 2007



Lock and key IInd order lever

$$L \times \text{Load arm} = \text{E} \times \text{Effort arm}$$

$$L \times 1 = 10 \times 4$$

$$L = 40 \text{ N}$$

Thus (a) is correct option.

Click Here to Buy book on Amazon

55. A uniform plank of a see-saw is 5m long and supported at its centre. A boy weighing 40 kg-f sits at a distance 1.5 m from one end of the see-saw where must a girl weighing 25 kg-f sit on the other end of the see-saw so as to balance the boy ?

(a) 0.9 m (b) 1.1 m
(c) 0.8 m (d) 0.2 m

Ans : COMP 2011

$$AC = 1.5$$

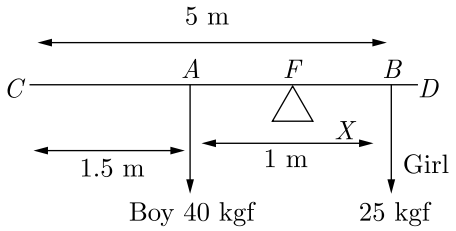
Hence, $AF = 2.5 - 1.5 = 1$ m

Effort $\times$ effort arm = Load $\times$ load arm

$$25 \times x = 40 \times 1$$

$$x = \frac{40}{25} = \frac{8}{5}$$

$$= 1.6 \text{ m} = BF$$



Hence,

distance from one end $D = BD$

$$BD = 2.5 - 1.6$$

$$= 0.9 \text{ m}$$

Thus (a) is correct option.

56. A machine is driven by a 100 kg mass that falls 8 m on 4 seconds. It lifts a load of mass 500 kg. If the efficiency of the machine is 75%, what is the power output ?

(a) 2500 W (b) 1000 W
(c) 150 W (d) 2000 W

Ans : COMP 2011

$$\text{Power} = \frac{\text{work done}}{\text{time taken}}$$

$$= \frac{F \times s}{t}$$

Given, $m = 100$ kg, $g = 10\,\text{m/s}^2$,

$t = 4$ s, $h = 8$ m

Hence, $\text{power} = \frac{mgh}{t}$

$$= \frac{100 \times 10 \times 8}{4}$$

$$= 2000 \text{ W}$$

Thus (d) is correct option.

57. A lever which always has mechanical advantage less than 1 has :

(a) Effort between the load and the fulcrum.
(b) Load between effort and the fulcrum.
(c) Effort and load act at same point
(d) Fulcrum between the load and effort.

Ans : MAIN 2019

Thus (a) is correct option.

58. A pulley system has 5 pulley in all. Its velocity ratio is :

(a) less than 5 (b) more than 5
(c) 5 (d) none of these

Ans : COMP 2005

Thus (c) is correct option.

59. The MA of sugar tongs is

(a) < 1 (b) > 1
(c) $= 1$ (d) None of these

Ans : SQP 2013

Hence, $MA = \frac{\text{Load}}{\text{Effort}}$

In case of sugar tongs, its a 3rd class lever, effort lies between fulcrum arm and load, hence $MA < 1$, effort is greater than load and

$$VR = \frac{dE}{dL}, d_E < d_L$$

Hence, $MA < 1$

Thus (b) is correct option.

60. The correct relationship between the velocity ratio ($V.R.$) the distance through which effort act (d) and the distance through which load moves (D)

(a) $V.R. \times d = D$ (b) $V.R. = D \times d$
(c) $V.R. \times D = d$ (d) none of these

Ans : MAIN 2016

Thus (c) is correct option.

61. A nut can be opened by a lever of length 0.25 m by applying a force of 80 N. What should be the length of lever, if a force of 32 N is enough to open the nut ?

(a) 1.5 m (b) 3.0 m
(c) 0.18 m (d) 0.625 m

Ans : COMP 2017

$$32 \text{ N} \times \text{Force arm} = 80 \text{ N} \times 0.25 \text{ m}$$

$$\text{Force arm} = \frac{80}{32} \times \frac{25}{100} = 0.625 \text{ m}$$

Thus (d) is correct option.

NODIA

62. The correct relationship between the efficiency (η) mechanical advantage ($M.A.$) and velocity ratio ($V.R.$) of an actual machine is :
(a) $\eta = M.A. \times V.R.$ (b) $\eta \times V.R. = M.A.$
(c) $\eta = \frac{M.A.}{V.R.}$ (d) both (b) and (c)

Ans : COMP 2004

Thus (b) is correct option.

63. An actual pulley system always has mechanical advantage less than velocity ratio. It is because :
(a) a part of effort is wasted in overcoming load of movable block
(b) a part of effort is wasted in overcoming friction.
(c) both (a) and (b)
(d) none of these

Ans : MAIN 2001

The mechanical advantage (M.A) of a real machine is always less than its velocity ratio (V.R) because mechanical advantage decreases due to the friction and weight of moving parts of the machine whereas the velocity ratio remains constant.
Thus (c) is correct option.

64. A lever which always have mechanical advantage more than 1 is :
(a) Lever of third order
(b) Lever of first order
(c) Lever of second order
(d) none of these

Ans : COMP 2014

In class II levers the fulcrum is at one end and the load is closer to the fulcrum. Thus, the effort arm is always longer than the load arm. Hence, the mechanical advantage of class II lever is always more than 1.
Thus (c) is correct option.

ASSERTION AND REASON

65. **Assertion (A):** A lever can be used to lift heavy objects with less effort.
Reason (R): A lever reduces the amount of force needed by increasing the distance over which the force is applied.
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Ans :

Levers work on the principle of mechanical advantage, allowing a smaller force to lift heavier loads by increasing the distance over which the force is applied.
Thus (a) is correct option.

66. **Assertion (A):** In a first-class lever, the fulcrum is located between the effort and the load.
Reason (R): First-class levers always provide a mechanical advantage greater than 1.
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Ans :

In a first-class lever, the fulcrum is indeed between the effort and the load, but the mechanical advantage can be greater than, equal to, or less than 1, depending on the positions of the effort and the load relative to the fulcrum.
Thus (c) is correct option.

67. **Assertion (A):** In a second-class lever, the load is located between the fulcrum and the effort.
Reason (R): Second-class levers always provide a mechanical advantage greater than 1.
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Ans :

In second-class levers, the load is between the fulcrum and the effort, which always provides a mechanical advantage greater than 1 because the effort arm is longer than the load arm.
Thus (a) is correct option.

68. **Assertion (A):** Scissors are an example of a first-class lever.
Reason (R): In a pair of scissors, the fulcrum is between the handles (effort) and the blades (load).

(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Ans :

Scissors are a first-class lever where the fulcrum is positioned between the handles (where effort is applied) and the blades (which perform the cutting action).
Thus (a) is correct option.

69. **Assertion (A):** A wheelbarrow is an example of a second-class lever.
Reason (R): In a wheelbarrow, the effort is applied between the fulcrum and the load.
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Ans :

A wheelbarrow is a second-class lever where the load is positioned between the fulcrum (the wheel) and the effort (the handles).
Thus (c) is correct option.

70. **Assertion (A):** A pair of pliers is an example of a third-class lever.
Reason (R): In a third-class lever, the effort is applied between the load and the fulcrum.
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Ans :

A pair of pliers is a first-class lever because the fulcrum is between the load and the effort. In a third-class lever, the effort is applied between the load and the fulcrum, such as in a pair of tweezers.
Thus (d) is correct option.

71. **Assertion (A):** The mechanical advantage of a lever can be calculated by dividing the length of the effort arm by the length of the load arm.
Reason (R): The mechanical advantage of a lever depends on the position of the fulcrum.
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Ans :

The mechanical advantage (MA) of a lever is indeed calculated by the ratio of the length of the effort arm to the length of the load arm, which depends on the position of the fulcrum.
Thus (a) is correct option.

72. **Assertion (A):** A fishing rod is an example of a third-class lever.
Reason (R): In a third-class lever, the effort is applied between the load and the fulcrum.
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Ans :

A fishing rod is a third-class lever where the effort is applied between the load (the fish) and the fulcrum (the hand holding the rod).
Thus (a) is correct option.

73. **Assertion (A):** In a first-class lever, if the distance from the fulcrum to the load is increased, the effort needed to lift the load decreases.
Reason (R): Increasing the load arm length in a lever decreases the mechanical advantage.
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Ans :

In a first-class lever, if the distance from the fulcrum to the load (load arm) is increased, the effort needed to lift the load increases, not decreases. The mechanical advantage decreases when the load arm length is increased.
Thus (c) is correct option.

74. **Assertion (A):** In a third-class lever, the mechanical advantage is always less than 1.
Reason (R): In a third-class lever, the effort arm is shorter than the load arm.

Downloaded from www.pdf.tube

(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Ans :

In a third-class lever, the effort is applied closer to the fulcrum than the load, making the effort arm shorter than the load arm, resulting in a mechanical advantage less than 1.
Thus (a) is correct option.

ONE MARK QUESTIONS

DIRECTION : Complete the following by choosing the correct answers from the bracket:

75. A _____ (class I/class II/Class III) lever will always have M.A. > 1.

Ans : SQP 2025

Class II

76. In a block and tackle system, increase in the weight of the movable block _____ (decreases, does not affect, increases) the efficiency of the pulley system.

Ans : SQP 2025

Decreases

77. A scissor is a _____ multiplier.

Ans : MAIN 2020

A scissor is a speed multiplier

78. kWh = _____J.

Ans : SQP 2015

1 kWh = 3.6×10^6 J

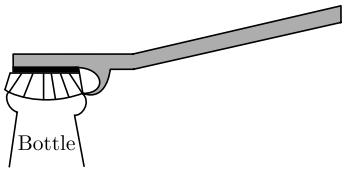
79. A scissor is a _____ multiplier.

Ans : COMP 2015

Velocity.

DIRECTION : Answer the following :

80. Name the class of the lever shown in the picture below:



Ans : MAIN 2024

Class II lever.

81. Why is a jack screw provided with a long arm?

Ans : MAIN 2018

As a large mechanical advantage is required by the jack screw used for cutting metal, hence its handle should be long and the blades short.

82. With reference to the terms mechanical advantage, velocity ratio and efficiency of a machine, name and define the term that will not change for a machine of a given design.

Ans : COMP 2022

The velocity ratio of a machine is defined as the ratio of velocity of the effort to the velocity of the load.

83. What is the principle of an ideal machine?

Ans : COMP 2014

Principle of an ideal machine is work done by a machine = work done on the machine
i.e., Work output = work input

84. Define an inclined plane.

Ans : MAIN 2005

An inclined plane is a simple machine consisting of a plank kept at a certain inclination to the ground. It acts as a force multiplier and has a M.A. greater than one.

85. What is the unit of mechanical advantage?

Ans : SQP 2004

Mechanical advantage is the ratio of two forces, therefore, it does not have a unit. Mechanical advantage can be equal to, less than or greater than one.

86. Name the two simple types of machines.

Ans : MAIN 2002

The six simple machines are :
(i) Lever
(ii) Wheel and axle

NODIA

87. What is a pulley ?

Ans : SQP 2000

A pulley is a metallic or wooden disc with a grooved rim. The pulley rotates about an axis passing through its centre. The axle is fixed to a frame or a block.

88. What is a single fixed pulley? Give its one use.

Ans : MAIN 2020

A single fixed pulley has its axis of rotation fixed and hence is called a fixed pulley. It is used to lift (or raise) a water bucket from the well. It is used to change the direction of the effort.

89. Write an expression to show the relationship between mechanical advantage, velocity ratio and efficiency for a simple machine.

Ans : SQP 2016

$$\text{Efficiency} = \frac{\text{Mechanical advantage}}{\text{Velocity ratio}}$$

90. What is a machine ?

Ans : COMP 2011

A machine is a device which is used to transmit force, to change the direction of force or to obtain speed.

91. What do you understand by the term effort?

Ans : SQP 2020

The effort (E) is the force applied on the machine.

92. What do you understand by the term load?

Ans : COMP 2023

The resistance (load, L) is the force overcome by the machine.

93. What is the principle of a machine?

Ans : MAIN 2000

All simple machines follow the law:
Resistance force (load) $\times$ Resistance (load) arm
$=$ Effort force $\times$ Effort arm

94. Give the expression for mechanical advantage of an inclined plane in terms of the length of an inclined plane.

Ans : SQP 2019

$$\text{M.A.} = \frac{L}{h}$$

95. Name a common device where a gear train is used.

Ans : SQP 2016

Watch.

96. What is mechanical advantage of a machine? How is it represented mathematically?

Ans : SQP 2020

It is defined as the ratio of the resistance force (load, L) to the effort force (E).
Mathematically, we have

$$\text{M.A.} = \frac{\text{Resistance force (Load)}}{\text{Effort force}}$$
$$= \frac{L}{E}$$

97. Define efficiency of a machine. Express it mathematically.

Ans : COMP 2015

The efficiency of a machine is the ratio of the work output to the work input. Mathematically, we have

$$\eta = \frac{\text{Work output}}{\text{Work input}}$$

98. What is the efficiency of an ideal machine?

Ans : SQP 2016

The efficiency of an ideal machine is 1 (or 100%).

99. Comment on the statement, "The mechanical advantage of a machine is greater than 1".

Ans : COMP 2002

The statement means that the effort required for the machine to overcome a load is less than the load.

100. What is the relation between mechanical advantage, velocity ratio and efficiency of a single fixed pulley?

Ans : MAIN 2010

In a fixed pulley;

$$\text{M.A.} = \text{V.R.} \times \text{Efficiency.}$$

101. What is the relation between the velocity ratio and the number of strands of string used to support the load, in a 'block and tackle set up' ?

Ans : SQP 2014

The velocity ratio of a 'block and tackle set up' is always equal to the number of strands of string used to support the load.

Click Here to Buy book on Amazon

102. What step could be taken to increase the mechanical advantage of a lever ?

Ans : COMP 2009

The length of the effort arm should be increased and made greater than the load arm.

103. What is meant by an ideal machine?

Ans : COMP 2002

For an ideal machine there is no dissipation of energy in any manner and the work output will be equal to the work input, i.e. the efficiency of ideal machine is 100%.

104. Write a relationship between the mechanical advantage (M.A.) and velocity ratio (V.R.) of an ideal machine.

Ans : MAIN 2006

For an ideal machine, $M.A. = V.R.$

TWO MARKS QUESTIONS

105. Meera choose to use a block and tackle system of '9' pulleys instead of a single movable pulley to lift a heavy load.
(a) What is the advantage of using a block and tackle system over a single movable pulley?
(b) Why should she connect more number of pulleys in the upper fixed block?

Ans : MAIN 2024

(a) Mechanical advantage using a block and tackle system of 9 pulleys is 9 whereas the mechanical advantage of a single movable pulley is 2.
(b) Increase of number of pulley increases mechanical advantage.

106. Classify machine in different categories.

Ans : COMP 2012

Simple machines can be classified into two major classes, i.e. the lever and the inclined plane. Lever is further classified into:
(i) Pulley
(ii) Gear
(iii) Wheel and Axle inclined plane is further classified as :
  (a) Wedge
  (b) Screw

107. Name a machine which can be used to :
(i) multiply force
(ii) change the direction of force applied.

Ans : MAIN 2020

(i) Single movable pulley.
(ii) Single fixed pulley.

108. Give one example each of a machine which is used to (i) Multiply force, (ii) Change direction of application of force.

Ans : MAIN 2016

(i) A jack is used to multiply force.
(ii) A pulley is used to change the direction of force.

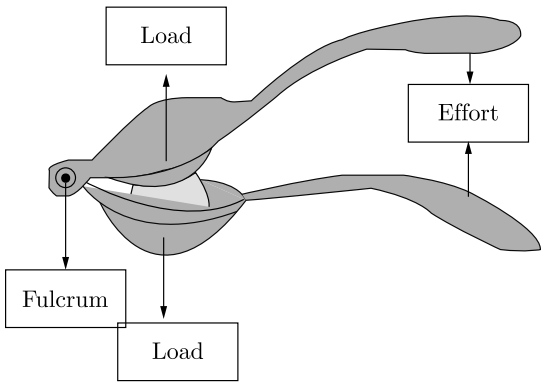
109. With reference to the terms Mechanical Advantage, Velocity Ratio and efficiency of a machine, name and define the term that will not change for a machine of a given design.

Ans : COMP 2016

It is velocity ratio that will not change for a machine of given design while mechanical advantage and efficiency can vary according to circumstances.

110. Draw a simplified diagram of a lemon crusher, indicating direction of load and effort.

Ans : SQP 2015



111. Name a machine which can be used to:
(a) multiply force,
(b) change the direction of force applied.

Ans : COMP 2011

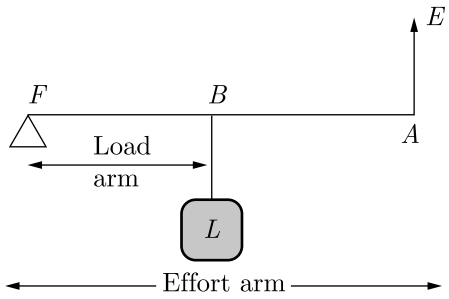
(a) A machine used to multiply force is a crowbar, shears, claw hammer, pliers or any example from second order lever, e.g. a nutcracker, a bottle opener or a single movable pulley.

(b) Single fixed pulley can be used to change the direction of force applied, i.e. using a single fixed pulley effort can be applied in a more convenient direction.

112. Draw a labelled sketch of a class II lever. Give one example of such a lever.

Ans : COMP 2018

Class II lever



Example: A wheelbarrow

113. State four functions of a simple machine.

Ans : MAIN 2013

Simple machines have the following functions:
(i) Act as a force multiplier
(ii) Act as a speed multiplier
(iii) Shift the point of application of the effort to a more convenient point.
(iv) Change the direction of the effort applied for greater ease and comfort.

114. Which class of lever found in the human body is being used by a boy
(a) When he holds a load on the palm of his hand?
(b) When he raises the weight of his body on his toes?

Ans : MAIN 2013

(a) Class III lever
(b) Class II lever

115. A type of single pulley is very often used as a machine even though it does not give any gain in mechanical advantage.
(i) Name the type of pulley used.
(ii) For what purpose is such a pulley used ?

Ans : SQP 2013

(i) Single fixed pulley.
(ii) It is used only to change the direction of force applied i.e., in a more convenient direction.

116. State the basic principle of a simple machine.

Ans : SQP 2010

According to the law of conservation of energy in a system, 'the energy can neither be created nor destroyed'. It implies that for a perfect machine work done on the machine (input), will be equal to the work done by the machine (output).

117. What do you mean by an ideal or perfect machine?

Ans : COMP 2019

An ideal or perfect machine means the machine whose parts are weightless and frictionless such that whatsoever amount of energy is spent on it, the same amount of energy is produced by it.

118. Differentiate between ideal mechanical advantage and actual mechanical advantage.

Ans : MAIN 2022

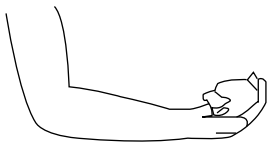
Ideal mechanical advantage	**Actual mechanical advantage**
It is the ratio of total load moved (L) /[useful load (l) + load due to movable parts of the machine + friction (f)]. IMA $= \frac{L}{E}$ or $\frac{(l+f)}{E}$	It is the ratio of useful load moved (l) to the effort (E) applied, i.e. to the effort applied. AMA $= \frac{l}{E}$

119. Why can a machine not be 100% efficient?

Ans : SQP 2019

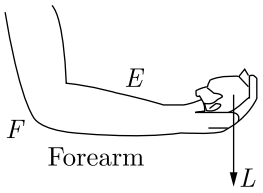
A machine cannot be 100% efficient because a part of input is:
(i) wasted in moving the parts of the machine, and
(ii) in overcoming friction between different parts of machine.

120. Copy the diagram of the forearm given below, indicate the positions of Load, Effort and Fulcrum.



Ans : COMP 2008

Downloaded from www.pdf.tube



121. Which class of levers has a mechanical advantage always greater than one? What change can be brought about in this lever to increase its mechanical advantage?

Ans : MAIN 2004

In class II lever effort arm is always greater than load arm. Therefore,

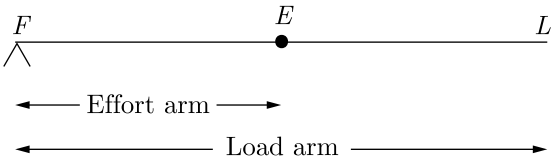
$$\text{Mechanical Advantage, } MA = \frac{\text{effort arm}}{\text{load arm}}$$

is always greater than one.
To increase its mechanical advantage, decrease its load arm.

122. Which class of levers has a mechanical advantage always less than one? Explain briefly with a diagram why their mechanical advantage is less than one.

Ans : SQP 2009

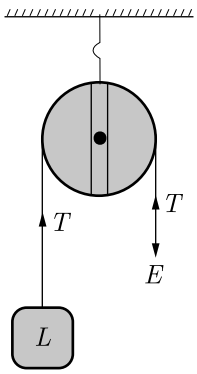
Mechanical advantage = effort arm/load arm.
In third class of levers, effort arm is always less than load arm, therefore mechanical advantage is always less than 1.



Example of class III lever is sugar tongs.

123. What is a single fixed pulley? Give its one use.

Ans : MAIN 2018



A single fixed pulley is a metallic/wooden grooved rim of the pulley which can rotate about an axis passing through its fixed centre. An inextensible string of negligible mass passes through the grooved rim of the pulley as shown in the diagram given below.
Use : It is used to change the direction of force applied.

124. Give two reasons why the efficiency of a single movable pulley system is not 100%.

Ans : MAIN 2021

In single movable pulley system efficiency is not 100% because:
(i) The weight of the movable pulley with its frame is not negligible compared to the effort.
(ii) The frictional force between the pulley wheel and the string used is not negligible.
(iii) The string is not inextensible and massless.

125. State the class of levers and the relative positions of load (L), effort (E) and fulcrum (F) in each of the following cases :
(i) A bottle opener
(ii) Sugar tongs.

Ans : SQP 2000

(i) Bottle opener is class II lever in which load is in between fulcrum and effort.
(ii) Sugar tongs is a class III lever in which effort is in between load and fulcrum.

126. Why is less effort needed to lift a load over an inclined plane as compared to lifting the load directly?

Ans : COMP 2012

To lift a load over an inclined plane as compared to lifting the load directly, less effort is required because mechanical advantage of inclined plane is greater than one.

127. Why is the mechanical advantage of a lever of the second order always greater than one ?

Ans : MAIN 2020

The mechanical advantage of a lever of the second order is always greater than one because effort arm is greater than load arm.

128. Name the type of single pulley that has a mechanical advantage greater than one.

Ans : SQP 2005

NODIA

Single movable pulley has a mechanical advantage greater than one.

129. In what way does an 'Ideal machine' differ from a 'Practical machine' ?

Ans : COMP 2008

Ideal machine is free from friction or Output work = Input work or efficiency is 100% whereas for all practical machines due to friction there is always loss in energy and efficiency is less than 100% and V.R. is not equal to M.A. or output work is less than input work.

130. Can a simple machine act as a force multiplier and a speed multiplier at the same time ?

Ans : SQP 2013

No, a simple machine at one time can act as a force multiplier where effort arm is bigger than load arm but at some other time can act as speed multiplier where effort arm is smaller than load arm so it is not possible at one time.

131. A type of single pulley is very often used as a machine even though it does not give any gain in mechanical advantage.
(a) Name the type of pulley used.
(b) For what purpose is such a pulley used?

Ans : COMP 2015

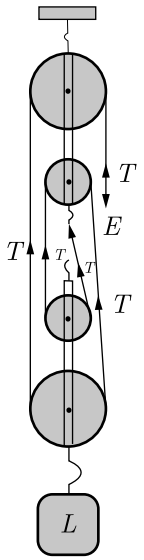
(a) Single fixed pulley.
(b) Single fixed pulley is used to change the direction of effort applied.

THREE MARKS QUESTIONS

132. A block and tackle system of pulleys has velocity ratio 4.
(a) Draw a labelled diagram of the system indicating clearly, the direction of the load and effort.
(b) Calculate the potential energy of the load 100 kgf lifted by this pulley to a height 5 m. ($g = 10\ ms^{-2}$)

NO NEED TO PURCHASE SAMPLE PAPERS
Download India's Best 20 Sample Papers
DOWNLOAD NODIA APP
Every School conduct Pre-Board
From These Sample Papers

Ans : SQP 2025



(a) Pulleys drawn correctly with support Correct connection of tackle, Marking load, effort with correct direction and tension

(b) $U = mgh = 100 \times 10 \times 5$

$U = 5000\ J$

133. Derive a relationship between mechanical advantage, velocity ratio and efficiency of a machine.

Ans : SQP 2014

Let a machine overcome a load L by the application of an effort E, in time t. Let the displacement of effort be d_E and the displacement of load be d_L.

Work input of effort= Effort × displacement of effort

$$= E \times d_E$$

Work output of load= Load × displacement of load

$$= L \times d_L$$

Efficiency, $$(\eta) = \frac{\text{Work output}}{\text{Work input}}$$

$$= \frac{L \times d_L}{E \times d_E}$$

$$= \frac{L}{E} \times \frac{d_L}{d_E}$$

Now, $$\frac{L}{E} = \text{M.A.}$$

And $$\frac{d_E}{d_L} = \text{V.R.}$$

Therefore, we have Efficiency $= \eta = \frac{\text{M.A.}}{\text{V.R.}}$

Thus, the mechanical advantage of a machine is equal to the product of its velocity ratio and efficiency.

Click Here to Buy book on Amazon

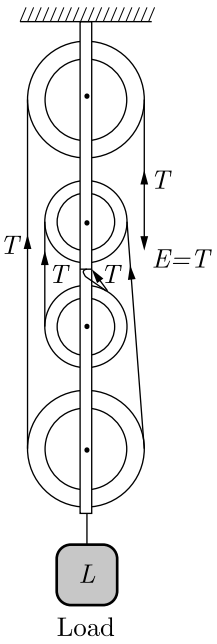
134. A block and tackle system of pulleys has velocity ratio 4.

(i) Draw a neat labelled diagram of the system indicating clearly the points of application and direction of load and effort.

(ii) What will be its V.R., if the weight of the movable block is doubled?

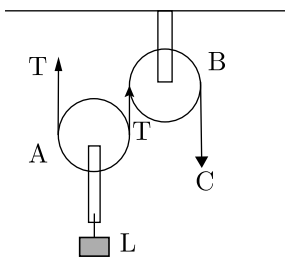
Ans : COMP 2020

(i) The labelled diagram is as shown below.



(ii) There is no change in the velocity ratio i.e., it will remain 4.

135. From the diagram given below, answer the questions that follow:



(a) What kind of pulleys are A and B?

(b) State the purpose of pulley B.

(c) What effort has to be applied at C to just raise the load $L = 20$ kgf?

(Neglect the weight of pulley A and friction).

Ans : MAIN 2016

(a) In the shown diagram B is the fixed pulley and A is the movable pulley to which the load is attached.

(b) The purpose of pulley B is to change the direction of effort from upward to the downward direction in a convenient manner.

(c) Given,

Load, $L = 20$ kg f, $E = ?$

In equilibrium $L = 2T$

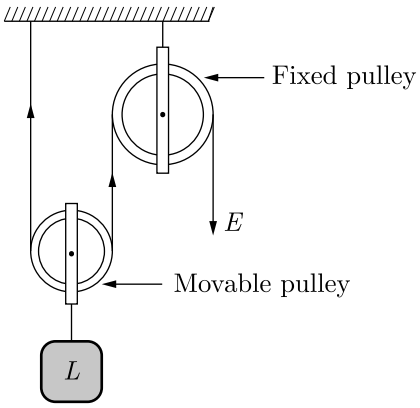
At C, effort $E = T$

Effort required, $E =$ half of the load

$$= \frac{20 \text{ kg } f}{2} = 10 \text{ kg f}$$

136. Draw a diagram to show how a single pulley can be used so as to have its ideal M.A. = 2. Derive a relationship between mechanical advantage, velocity ratio and efficiency of a machine.

Ans : SQP 2014



In equilibrium;

Load, $L = T + F = 2T$

Effort, $E = T$

Mechanical advantage,

$$MA = \frac{\text{Load}}{\text{Effort}}$$

$$= \frac{2T}{T} = 2$$

For an ideal machine

Work output, $(W_0) =$ Work output (W_i)

Efficiency,

$$\eta = \frac{\text{Work output } (W_0)}{\text{Work input } (W_i)}$$

$$= \frac{\text{Load } (L) \times \text{displacement of the load } (d_L)}{\text{Effort } (E) \times \text{displacement of the effort } (d_E)}$$

$$\eta = \frac{L \times d}{E \times d_E}$$

$$= \frac{MA}{VR} \{MA = L/E, VR = d_E/d_L\}$$

Downloaded from www.pdf.tube

137. A block and tackle system of pulleys has a velocity ratio 4.

(i) Draw a labelled diagram of the system indicating clearly the points of application and directions of load and effort.

(ii) What is the value of the mechanical advantage of the given pulley system if it is an ideal pulley system ?

Ans : SQP 2013

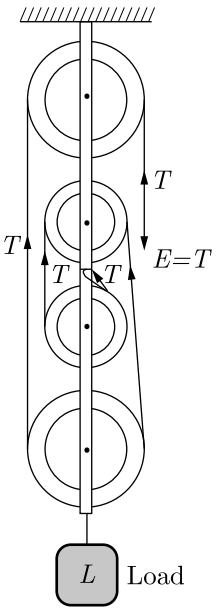
(i) $\text{Load} = 4\,\text{T}$

$E = T$

Velocity Ration V.R. $= 4$

Block and tackle system of pulley having

V.R. $= 4$



(ii) M.A. = V.R., if it is ideal pulley $= 4$

138. Give two reasons why the efficiency of a single movable

(i) What is meant by an ideal machine ?

(ii) Write a relationship between the mechanical advantage (M.A.) and velocity ratio (V.R.) of an ideal machine.

Ans : COMP 2020

(i) In an ideal machine, the work output is equal to the work input i.e., the efficiency of an ideal machine is 100%.

(ii) $\text{Efficiency} = \dfrac{\text{M.A.}}{\text{V.R.}}$

In an ideal machine, ratio $= 1:1$

NODIA

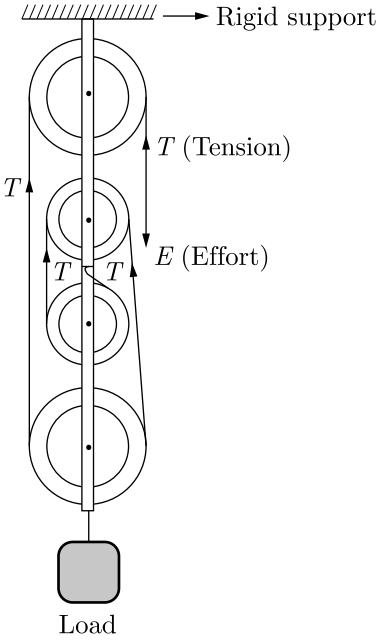
139. A block and tackle system of pulleys has a velocity ratio 4.

(a) Draw a labelled diagram of the system indicating clearly the points of application and directions of load and effort.

(b) What is the value of the mechanical advantage of the given pulley system if it is an ideal pulley system?

Ans : COMP 2013

(a)



(b) For an ideal pulley system

$$MA = \frac{L}{E}$$

Where, $L = nT = 4T$

$E = T$

$MA = 4T/T = 4$

140. (i) With reference to the terms mechanical advantage, velocity ratio and efficiency of a machine, name the term that will not change for a machine of a given design.

(ii) Define the term stated by you in part (i).

Ans : MAIN 2009

(i) Velocity ratio will not change for a machine of a given design (as M.A. depends on load applied and effort) and (efficiency depends on (a) wear and tear of machinery, (b) mechanical advantage).

(ii) Velocity ratio is the ratio of velocity of effort to the velocity of load. It has no units.

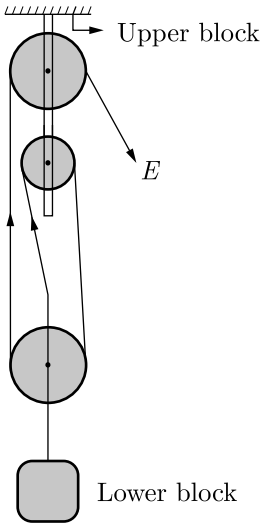
141. A block and tackle pulley system has a velocity ratio 3.

(i) Draw a labelled diagram of this system. In your diagram, indicate clearly the points of application and direction of the load and effort.

(ii) Why should the lower block of this pulley system be of negligible weight ?

Ans : SQP 2007

(i) The labelled diagram of the block and tackle with a velocity ratio 3 is as shown, the total number of pulleys is 3.



(ii) The lower block of this pulley system must have negligible weight so that, the mechanical advantage is maximum.

142. Explain why scissors for cutting cloth may have blades much longer than the handles; but shears for cutting metals have short blades and long handles.

Ans : COMP 2004

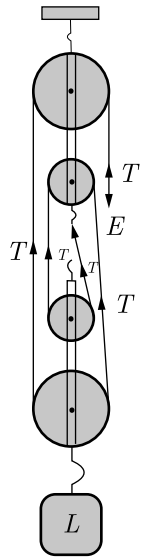
The resistance offered by cloth is much less than that offered by metals. Therefore, we do not require a large mechanical advantage from scissors which is to cut cloth. At the same time, a large mechanical advantage is required by the scissors used for cutting metal, hence its handle should be long and the blades short. (M.A. = effort arm/ load arm).

143. (a) Draw a labelled diagram of a block and tackle system of pulleys with two pulleys in each block. Indicate the directions of the load, effort and tension in the string.

(b) Write down the relation between the load and the effort of the pulley system.

Ans : MAIN 2020

(a)



(b) Load/Effort = Mechanical advantage

$$\text{MA} = \frac{4T}{T} = 4$$

144. Explain why scissors for cutting cloth may have blades much longer than the handles; but shears for cutting metals have short blades and long handles.

Ans : SQP 2022

Scissors for cutting cloth and shears for cutting metals both belong to class I levers. For class I levers mechanical advantage (MA = Effort arm/ Load arm) may be $>, =$ or < 1. For cutting cloth less mechanical advantage is required than for cutting/metals. That is why scissors may have blades much longer than the handles. On the other hand shears for cutting metals have short blades and long handles.

145. Obtain relation between ideal mechanical advantage and velocity ratio for an ideal machine.

Ans : COMP 2001

Let an ideal machine overcome a total load (L) by the application of an effort (E). In time t, let the displacement of the effort and load are d_E and d_L respectively.

By the principle of an ideal machine

Output of machine = Input of machine

$$L \times d_L = E \times d_E$$

Click Here to Buy book on Amazon

$$(L/E) = d_E/d_L$$

Ideal mechanical advantage (IMA) = velocity ratio

146. What is the relationship between the mechanical advantage and the velocity ratio for:
(a) an ideal machine;
(b) a practical machine?

Ans : MAIN 2005

(a) For an ideal machine,

Mechanical advantage = Velocity ratio

(b) For a practical machine,

$$\text{Mechanical advantage} = VR - \frac{x}{E}$$

where, x is the resistance due to movable parts of machine and friction, and E is the effort.

147. Obtain the difference between ideal and actual mechanical advantage.

Ans : SQP 2015

Ideal mechanical advantage $\left(\frac{L}{E}\right)$ = Velocity ratio (VR)
Where, L is the total load which is the sum of useful load (l) + resistance due to movable parts of machine and friction (f), i.e. $L = 1 + f$

$$\frac{1+f}{E} = VR \Rightarrow \frac{1}{E} + \frac{f}{E} = VR$$

$$AMA + \frac{f}{E} = VR$$

$$\left\{\frac{\text{useful load}}{\text{effort}} = AMA, VR = IMA\right\}$$

$$AMA + \frac{f}{E} = IMA \Rightarrow (IMA - AMA) = \frac{f}{E}$$

148. Why are the cutting edges of scissors made longer than the cutting edges of metal cutter?

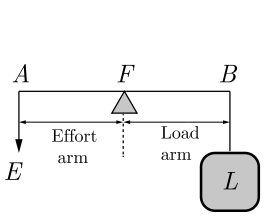
Ans : SQP 2004

In scissors, cutting edge (load arm) is generally longer than effort arm because the load (cloth/ paper) is of small magnitude than the effort available from hands while in metal cutter load of metal is very large. Thus, to overcome this large resistance, effort arm is made longer so that output can be obtained by applying less effort.

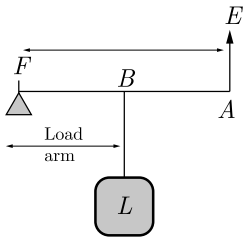
149. How do you define a lever? Give diagrammatic representation of different types of levers.

Ans : COMP 2020

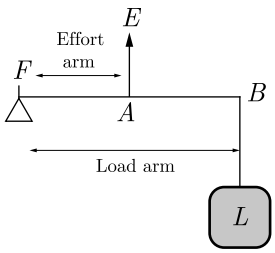
Lever is a rigid, straight or bent bar which is capable of turning about a fixed turning point or an axis (called fulcrum). Depending upon the relative positions of the load, effort and fulcrum, levers can be represented by the following figures.



Class 1 lever



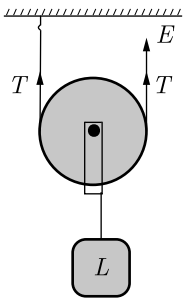
Class 2 lever

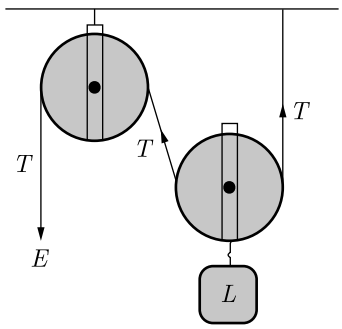


Class 3 lever

150. Draw the diagram of a single movable pulley and obtain its mechanical advantage, velocity ratio and efficiency.

Ans : MAIN 2010





Since it is inconvenient to apply the effort in an upward direction, a single fixed pulley is used to change the direction of effort.

NODIA

In equilibrium, $L = T + T = 2T$

$$E = T$$

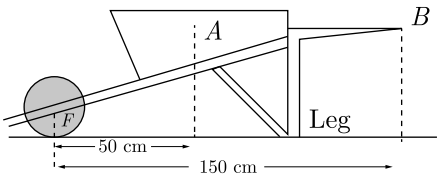
$$\text{Mechanical advantage} = \frac{\text{Load}\,(L)}{\text{Effort}\,(E)} = \frac{2T}{T} = 2$$

As the effort is pulled down through a distance dE, the two segments of the thread carrying the movable pulley and the load goes up by $d_E/2$ Hence $d_L = d_E/2$

$$\text{Velocity ratio,} \quad VR = \frac{d_E}{d_L} = \frac{d_E}{d_E/2} = 2$$

$$\text{Efficiency} = \frac{MA}{VR} = \frac{2}{2} = 1 \text{ or } 100\%$$

151. In the diagram of a stationary wheelbarrow, the centre of gravity is at A. The wheel and the leg are in contact with the ground. The horizontal distance between A and F is 50 cm and that between B and F is 150 cm.



(a) What is the direction of the force acting at A ? Name the force.

(b) What is the direction of the minimum force at B to keep the leg off the ground? What is this force called?

Ans : COMP 2001

(a) At point A, the weight of wheelbarrow and sand acts vertically downwards. It is called load.

(b) The direction of the minimum force at B to keep the leg off the ground vertically upwards is called effort and denoted by E.

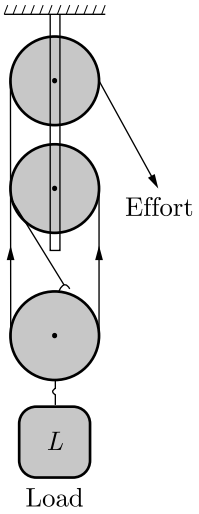
152. A block and tackle pulley system has a velocity ratio 3.

(a) Draw a labelled diagram of this system. In your diagram, indicate clearly the points of application and the directions of the load and effort.

(b) Why should the lower block of this pulley system be of negligible weight?

Ans : SQP 2006

(a)



(b) If w be the total weight of pulleys in the lower block, in the balanced position

$$\frac{MA}{VR} = \frac{\eta - \frac{w}{E}}{n} = 1 - \frac{w}{nE}$$

From the expression it is clear that for greater efficiency, $\frac{w}{nE}$ should be negligible. The pulleys in the lower block should be as light as possible.

153. What is the relation between the mechanical advantage and the number of strands of string used to support the load, in a 'block and tackle set up'?

Ans : MAIN 2020

The mechanical advantage of a block and tackle arrangement is equal to the number of strands of string, used to support the load.

This is true only if the 'block and tackle set up' can be assumed to be ideal (absence of friction, etc.) and the lower blocks of pulleys have a negligible weight. Since both these conditions cannot be satisfied in actual practice, hence, practically, the M.A. of a 'block and tackle set up' is always less than the number of strands of string used to support the load.

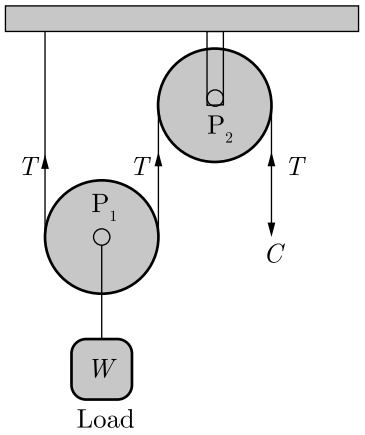
154. What is a pulley? What is the mechanical advantage of a single fixed pulley?

Ans : COMP 2019

A pulley is a metallic or wooden disc with a grooved rim. The pulley rotates about an axis passing through its centre. The axle is fixed to a frame or a block. A single fixed pulley has its axis of rotation fixed and hence is called a fixed pulley. The mechanical advantage of a single fixed pulley is one. It simply changes the direction of application of force.

Downloaded from www.pdf.tube

155. The given figure shows the combination of a movable pulley P_1 with a fixed pulley P_2 used for lifting up a load (W).



(a) State the function of the fixed pulley P_2.
(b) If the free end of the string moves through a distance x, find the distance by which the load $w$is raised.
(c) Calculate the force to be applied at C to just raise the load $w = 20$ kg f, neglecting the weight of the pulley P_1 and friction.

Ans : COMP 2009

(a) Fixed pulley P_2 is used to change the direction of effort to a convenient direction.
(b) As the free end of the string moves through a distance x, there being two segments of the thread carrying the movable pulley, the load w is raised up by $2 - x$ distance ; because each segment of thread shortens by a distance $2 - x$.
(c) In equilibrium, $L = T + T = 2T$

Force applied at C = Effort $(E) = T$

$$\frac{L}{E} = \frac{2T}{T}$$

$$= 2 \Rightarrow \frac{20 \text{ kg f}}{E} = 2$$

$$\Rightarrow E = 10 \text{ kg f}$$

156. What is velocity ratio? Express it mathematically.

Ans : MAIN 2003

It is defined as the ratio of the velocity of the effort (v_E) to the velocity of the resistance force (Load) (v_L). Mathematically, we have

$$\text{V.R.} = \frac{\text{Velocity of effort}}{\text{Velocity of load}} = \frac{v_E}{v_L}$$

It is also defined as the ratio of the displacement of the effort to the displacement of the load. Mathematically,

$$\text{V.R.} = \frac{\text{Velocity of effort}}{\text{Velocity of load}}$$

$$= \frac{v_E}{v_L}$$

$$= \frac{d_E/t}{d_L/t} = \frac{d_E}{d_L}$$

Since velocity ratio is the ratio of similar quantities, therefore, it does not have a unit.

157. Give an example for each of the following use of a machine:
(i) To change the point of application of the force.
(ii) To obtain a gain in force.
(iii) To change the direction of force.

Ans : SQP 2011

(i) Rotating the wheel of a cycle by applying force on the pedal with the help of chain.
(ii) Lifting a car with a jack.
(iii) Lifting a bucket full of water from the well using a single fixed pulley.

NODIA

158. State the two reasons, why the efficiency of a pulley system is not 100 percent.

Ans : SQP 2012

The two reasons are :
(i) Some effort is used up (or wasted) in overcoming friction between the string and the grooves of the pulleys.
(ii) Some effort is used up (or wasted) in lifting up the movable block along with the load.
On account of the above two reasons, the M.A. is always less than V.R. Hence, efficiency is always less than 100%.

159. (a) With reference to the terms mechanical advantage, velocity ratio and efficiency of a machine, name the term that will not change for a machine of a given design.
(b) Define the term stated by you in part (a).

Ans : MAIN 2000

(a) Velocity ratio.
(b) The velocity ratio of a machine is defined as the ratio of velocity of the effort to the velocity of the load.

$$\text{Velocity Ratio (VR)} = \frac{\text{Velocity effort } (V_E)}{\text{Velocity of load } (V_L)}$$

If V_E and V_L are the velocities and d_E and d_L are the displacements of the effort and load respectively acting for a time t then

$$VR = \frac{(d_E/t)}{(d_L/t)} = \frac{d_E}{d_L}$$

160. Find the mechanical advantage of the given arrangement of four pulleys.

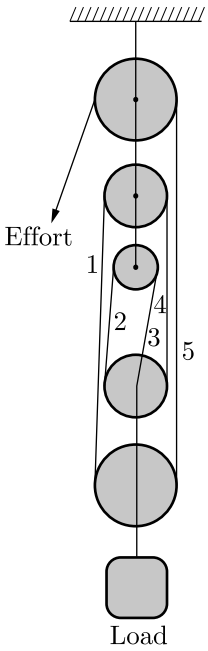
Ans : SQP 2016

Let T be the common value of tension in all the parts of the string. This must be equal to E, the applied effort.

Since a total 4 of these tensions support the load, we have

$$4E = L \qquad (T = E)$$

$$\text{Mechanical advantage} = \frac{\text{Load}}{\text{Effort}} = \frac{4E}{E} = 4$$



The mechanical advantage of the system is 4.

161. Give the definitions of Mechanical Advantage, Velocity Ratio and Efficiency of machine. What is the relation between them ?

Ans : COMP 2008

Mechanical Advantage is the ratio of the load to the effort.

$$\text{M.A.} = \frac{\text{Load}}{\text{Effort}}$$

Velocity Ratio is the ratio of the velocity of the effort to the velocity of load. If d_L and d_E are the distances moved in time t second by the load and the effort respectively, then

$$\text{Velocity of load} = d_L/t$$

$$\text{Velocity of effort} = d_E/t$$

$$\text{V.R.} = \frac{\text{Velocity of effort}}{\text{Velocity of load}}$$

$$= \frac{d_E/t}{d_L/t}$$

$$\text{V.R.} = \frac{d_E}{d_L}$$

Thus, velocity ratio is also defined as the ratio of the displacement of effort to the displacement of load.

Efficiency is the ratio of the work output to the work input.

$$\eta = \frac{\text{Work output}}{\text{Work input}} \times 100\%$$

$$\eta = \frac{\text{M.A.}}{\text{V.R.}}$$

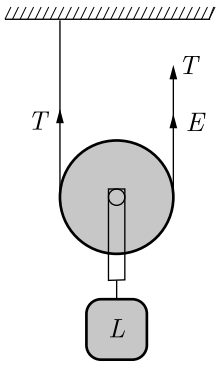
162. Show that the M.A. = 2 in case of single movable pulley.

Ans : MAIN 2002

$$L = T + T = 2\text{T}$$

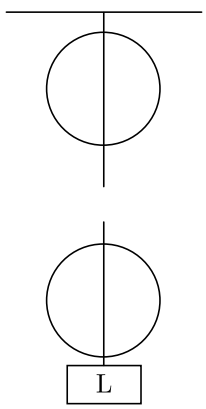
But, $E = T$

$$\text{M.A.} = \frac{L}{E} = \frac{2\text{T}}{T} = 2$$



FOUR MARKS QUESTIONS

163. Two pulleys are given as below.



Click Here to Buy book on Amazon

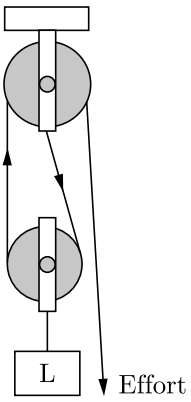
(a) Copy and complete the labelled diagram connecting the two pulleys with a tackle to obtain Velocity Ratio = 2.

(b) If Load = 48 kgf and efficiency is 80% then calculate:

1. Mechanical Advantage.
2. Effort needed to lift the load.

Ans : MAIN 2024

(a)



(b) 1. $\text{Efficiency} = \frac{\text{M.A.}}{\text{V.R.}}$

$$0.8 = \frac{\text{M.A.}}{2}$$

$$\text{M.A.} = 1.6$$

2. $$\text{Effort} = \frac{\text{Load}}{\text{M.A.}} = \frac{48}{1.6}$$

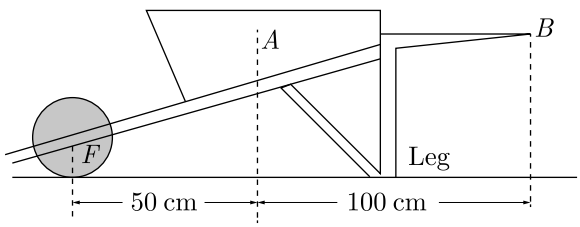
$$= 30 \text{ kgf}$$

164. A stationary wheel barrow has its centre of gravity at A. The wheel and the leg are in contact with the ground. The horizontal distance between A and F is 50 cm and that between B and F is 150 cm.

(i) What is the direction of the force acting at A ? Name the force.

(ii) What is the direction of the minimum force at B to keep the legs off ground? What is this force called?

(iii) The weight of the wheel barrow is 15 kgf. It holds sand of weight 60 kgf. Calculate the minimum force required to keep the leg just off the ground.



Ans : MAIN 2000

(i) The force is acting downwards. The force is the weight of the wheel barrow. It is the load.

(ii) The minimum force acts upwards. This force is the effort.

(iii) According to the principle of moments, Taking moments about the fulcrum.

$$\text{Load} \times \text{Load arm} = \text{Effort} \times \text{Effort arm}$$

$$(60 + 15) \times 50 = 150 \times E$$

$$75 \times 50 = 150 \times E$$

$$E = \frac{75 \times 50}{150}$$

$$E = 25 \text{ kgf}$$

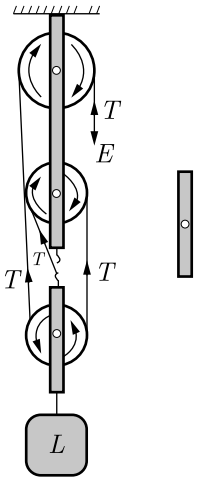
165. (i) Draw a diagram to show a block and tackle pulley system having a velocity ratio of 3 marking the direction of load (L), effort (E) and tension (T).

(ii) The pulley system drawn lifts a load of 150 N when an effort of 60 N is applied. Find its mechanical advantage.

(iii) Is the above pulley system an ideal machine or not?

Ans : COMP 2018

(i) The diagram is as shown below.



(ii) Actual M.A. number of pulleys in the system = 3

$$\text{Observed M.A.} = \frac{\text{Load}}{\text{Effort}}$$

$$= \frac{150}{60} = 2.5$$

(iii) Since observed M.A. is lesser than the theoretical M.A., therefore, the machine is not an ideal machine.

NODIA

166. Figure-2 given below gives an arrangement of single moving pulleys. Copy the diagram. If the effort applied at the free end of the string is E,

(i) Show the direction and the magnitude of the forces exerted by the four strings marked (1) to (4).

(ii) What is the load that can be lifted by the effort.

(iii) Calculate the mechanical advantage of the system of pulleys.

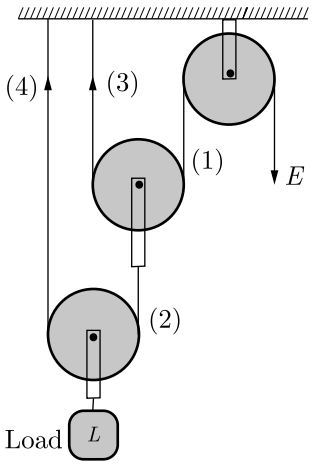


Figure 2

Ans : MAIN 2008

(i) The directions of the forces exerted by the four strings is as shown in Figure 2(a).

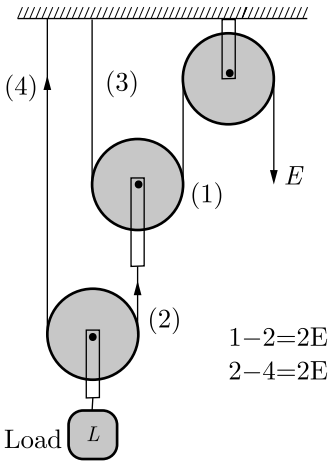


Figure 2(a)

(ii) Load $= 4 \times$ Effort

(iii) M.A. $=$ Load/Effort $= 4$.

167. Figure-1 given below shows an arrangement of four pulleys. A load L is attached to the movable lower block and an effort E is applied at the free end of the string. Copy the diagram and (i) draw arrows to indicate tension in each part of the string and (ii) calculate the mechanical advantage of the system.

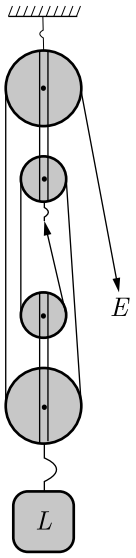


Figure 1

Ans : SQP 2005

(i) In completed diagram [shown in Figure 1(a)], the arrow heads are marked to indicate the tension in each part of the string passing over the pulleys.

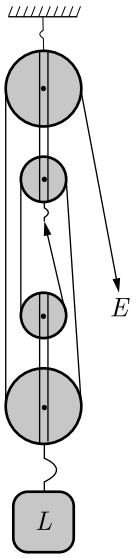


Figure 1(a)

(ii) Let us suppose that T is the common value of tension in all parts of the string. This means that this tension must be equal to the applied effort E. As the total number of tensions which support the load are 4, therefore, $L = 4\,\mathrm{E}$, hence mechanical advantage is

$$\text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{4\,\mathrm{E}}{E} = 4$$

168. Figure-3 shows a block and tackle of 5 pulleys.

(i) Copy the diagram and complete it by drawing a string around the pulleys. Mark the positions of the load and the effort.

(ii) If the load is raised by 1 in, through what distance will effort move?

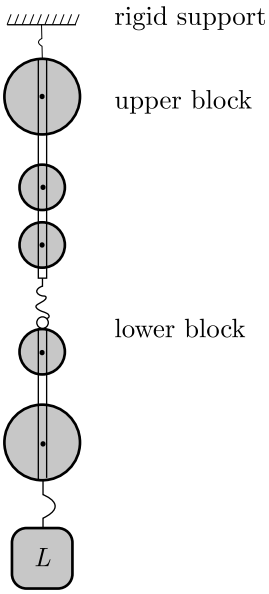


Figure 3

Ans : COMP 2009

(i) Correct winding of rope around pulleys, load and effort is as shown in Figure 3(a).

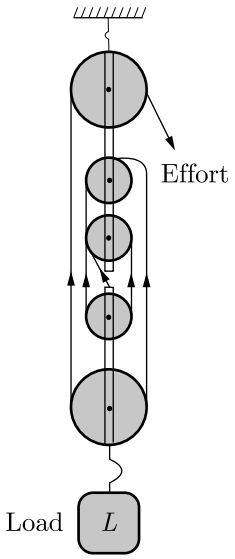


Figure 3(a)

(ii) Since there are five strings in the block and tackle system, therefore, the velocity ratio of the system is V.R. $= n = 5$.

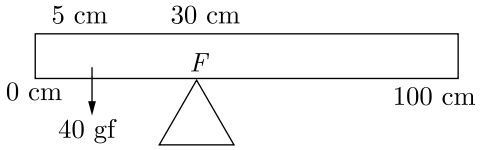
Now, $\text{V.R.} = \dfrac{d_E}{d_L}$

or $d_E = 5 \times d_L$

$= 5 \times 1 = 5\,\text{m}$

NUMERICAL QUESTION

169. A uniform metre scale is in equilibrium as shown in the diagram :



(i) Calculate the weight of the metre scale.

(ii) Which of the following options is correct to keep the ruler in equilibrium when 40 gf wt is shifted to 0 cm mark?

F is shifted towards 0 cm or

F is shifted towards 100 cm.

Ans : MAIN 2019

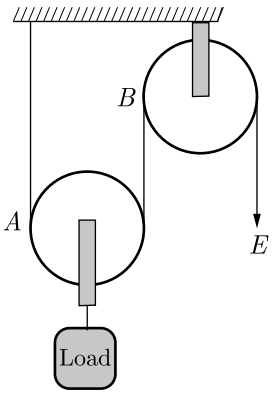
(i) The weight of the metre scale acts at its centre of gravity i.e., at 50 cm mark by the concept of moments, we have

$$40 \times (30 - 5) = W \times (50 - 30)$$

or $W = (40 \times 25)/20 = 50\,\text{gf}$

(ii) F is shifted towards 0 cm.

170. The diagram below shows a pulley arrangement :



(i) Copy the diagram and mark the direction of tension on each strand of the string.

(ii) What is the velocity ratio of the arrangement?

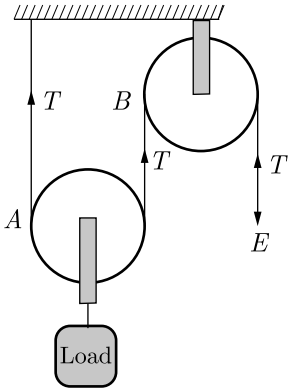
(iii) If the tension acting on the string is T, then what is the relationship between T and effort E?

Downloaded from www.pdf.tube

(iv) If the free end of the string moves through a distance x, find the distance by which the load is raised.

Ans : SQP 2019

(i) The direction of tension is as marked.



(ii) VR = Distance travelled by effort/Distance travelled by load $= \frac{2x}{x} = 2$

The distance travelled by load is half the distance moved by effort $= \frac{x}{2}$.

(iii) $T = E$

(iv) The distance travelled by load is half the distance moved by effort $= \frac{x}{2}$.

171. A boy uses a single fixed pulley to lift a load of 50 kgf to some height. Another boy uses a single movable pulley to lift the same load to the same height. Compare the effort applied by them. Give a reason to support your answer.

Ans : COMP 2017

A single fixed pulley simply changes the direction of the action of the force. Therefore, for this pulley $E = L = T = 50$ kgf. Thus, it has a mechanical advantage 1.

For a single movable pulley, we have $L = T + T = 2T$ and $E = T = L/2 = 50/2 = 25$ kgf, therefore, its mechanical advantage is 2.

172. A pulley system with velocity ration = 4 is used to lift a load of 175 kgf through a vertical height of 15 m. The effort required is 50 kgf in the downward direction, ($g = 10\ \text{N kg}^{-1}$). Calculate :

(i) Distance moved by the effort.

(ii) Work done by the effort.

(iii) M.A. of the pulley system.

(iv) Efficiency of the pulley system.

Ans : MAIN 2017

Given, V.R. = 4,

$L = 175$ kgf, distance moved by load $= d_L = 15$ m, $E = 50$ kgf, $d_E = ?$, $W_E = ?$, M.A. $= ?$, $h = ?$

Using the formula,

$$\text{V.R.} = \frac{\text{distance moved by effort}}{\text{distance moved by load}}$$

$$= \frac{d_E}{d_L}$$

Therefore, we have

$$d_E = \text{V.R.} \times d_L$$

$$= 4 \times 15 = 60\ \text{m}$$

$$W_E = \text{Effort} \times d_E$$

$$= 50 \times 10 \times 60 = 30000\ \text{J}$$

Now, $$\text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{175}{50} = 3.5$$

$$\eta = \frac{\text{M.A.}}{\text{V.R.}} = \frac{3.5}{4}$$

$$= 0.875 = 87.5\%$$

173. A block and tackle system has V.R. = 5.

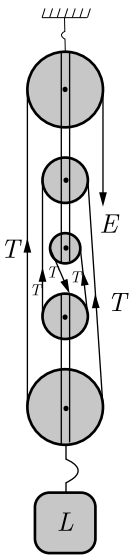
(a) Draw a neat labelled diagram of a system indicating the direction of its load and effort.

(b) Rohan exerts a pull of 150 kgf. What is the maximum load he can raise with this pulley system if its efficiency = 75% ?

Ans : COMP 2015

Diagram V.R. = 5

(a)



Block and Tackle system

(b) $VR = 5$,

Effort = 150 kg f,

Load = ?,

$$\text{Efficiency} = 75\%$$

$$\text{Efficiency} = \frac{MA}{VR}$$

$$\text{MA} = VR \times \text{Efficiency}$$

$$= 5 \times \frac{75}{100} = 3.75$$

$$\text{Load} = MA \times \text{Effort}$$

$$= 3.75 \times 150 \text{ kg f}$$

$$= 562.50 \text{ kgf}$$

174. A fulcrum divides a crowbar in the ratio 3 : 1. What weight will be lifted if an effort of 100 N is applied at the end of its longer arm?

Ans : MAIN 2003

Effort arm: Load arm = 3:1,

$$\text{Effort} = 100 \text{ N, Load} = ?$$

$$\frac{\text{Load}}{\text{Effort}} = \frac{\text{Effort arm}}{\text{Load arm}}$$

$$\Rightarrow \quad \frac{\text{Load}}{100 \text{ N}} = \frac{3}{1} \Rightarrow \text{Load} = 300 \text{ N}$$

175. Ramesh applies a force of 6 kg f to draw a 4.8 kg bucket of water from a well using a single fixed pulley. Assuming that all of the extra force applied is to overcome frictional forces, calculate force of friction, mechanical advantage and efficiency. (Take $g = 10 \text{ ms}^{-2}$).

Ans : SQP 2009

$$E = 6 \text{ kg } f = 6 \text{ kg } f \times 10 \text{ ms}^{-2} = 60 \text{ N},$$

$$L = 4.8 \text{ kg } f = 4.8 \text{ kg } f \times 10 \text{ ms}^{-2} = 48 \text{ N}$$

$$E = T = L + f$$

Where f is the force of friction

$$f = E - L$$

$$= 60 - 48 = 12 \text{ N}$$

$$MA = \frac{L}{E} = \frac{48 \text{ N}}{60 \text{ N}} = 0.80$$

$$\eta = \frac{MA}{VR}$$

For a single fixed pulley $VR = 1$

$$\frac{1.80}{1} = 0.8 = 80\%$$

176. A barrel of 50 kg is raised up on a 10 m long inclined plane by an effort of 25 N. Calculate (a) the vertical height through which barrel rises, (b) gradient of inclined plane. (Take $g = 10 \text{ ms}^2$)

Ans : COMP 2020

$$L = 50 \text{ kg} = 50 \text{ kg} \times 10 \text{ m}s^{-2} = 500 \text{ N},$$

$$E = 25 \text{ N}, \; l = 10 \text{ m}, \; h = ?$$

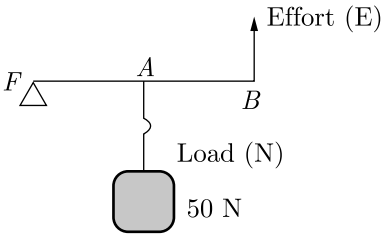
(a) We know that,

$$\frac{L}{E} = \frac{l}{h} \Rightarrow \frac{500 \text{ N}}{25 \text{ N}} = \frac{10}{\text{h}} \Rightarrow \text{h} = 0.05 \text{ m}$$

(b) Gradient of the inclined plane,

$$\frac{h}{l} = \frac{0.5}{10} = \frac{1}{20}$$

177. The diagram shows a lever in use



(a) To which class of lever does it belong?

(b) If FA = 40 cm, AB = 60 cm, then find the mechanical advantage of the lever.

Ans : MAIN 2011

(a) Second class of lever

(b) $$\text{M.A.} = \frac{\text{Effort arm}}{\text{Load arm}}$$

$$= \frac{(40 \text{ cm} + 60 \text{ cm})}{40 \text{ cm}}$$

$$= \frac{100}{40} = 2.5$$

178. A pulley system has a velocity ratio of 4 and an efficiency of 90%. Calculate:

(a) the mechanical advantage of the system.

(d) the effort required to raise a load of 300 N by the system.

Ans : SQP 2004

Velocity ratio of a pulley system $(VR) = 4$

Efficiency of the pulley system $\eta = 90\%$

(a) Efficiency

$$\eta = \frac{\text{Mechanical advantage } (MA)}{\text{Velocity ratio } (VR)}$$

$$= 90\%$$

$$= \frac{MA}{4}$$

$$MA = \frac{90}{100} \times 4 = 3.6$$

(b) Load, $L = 300 \text{ N}$, $MA = 3.6$, Effort, $E = ?$

$$MA = \frac{L}{E} \Rightarrow E\frac{L}{MA} = \frac{300 \text{ N}}{3.6} = 83.3 \text{ N}$$

Click Here to Buy book on Amazon

179. Calculate the power of a pump which can lift 400 kg of water to store it in a water tank at a height of 19 m in 40 s. (Take $g = 10\ \text{ms}^{-2}$)

Ans : COMP 2021

Given, $m = 400\ \text{kg};\ g = 10\ \text{ms}^{-2};$

$s = 19\ \text{m};\ t = 40\ \text{s};\ P = ?$

$$P = \frac{W}{t} = \frac{Fs}{t} = \frac{mgs}{t}$$

$$P = \frac{400 \times 10 \times 19}{40}$$

(As pump Works against gravity $F = mg$)

$$P = 1900\ \text{W}$$

180. A block and tackle of 5 pulleys is used to raise a load of 50 kg f steadily through a height of 20 m. The work done against friction is 2000 J. Calculate:
(a) the work done by the effort
(b) the efficiency of the system
(c) mechanical advantage.

Ans : MAIN 2015

Given, $L = 50\ \text{kg}\ f = 50 \times 10 = 500\ \text{N},$

$d_L = 20\ \text{m};\ W_f = 2000\ \text{J};$

$\text{n} = 5;\ = ?;\ E = ?;\ MA = ?$

(a) Work done by the effort,
$WE =$ Work done (in raising the load + against friction) $= 500\ \text{N} \times 20\ \text{m} + 2000\ \text{J} = 12000\ \text{J}$

(b) $$\eta = \frac{\text{Work done in rai sin g the load}}{\text{Total work done by the effort}}$$

$$= \frac{10000\ \text{J}}{12000\ \text{J}} = 0.833 = 83.3\%$$

(c) Work done by the effort, $W_E = E \times d_E$

$$12000\ \text{J} = E \times 100\ \text{m}$$

$$[d_E = 5d_L = 5 \times 20\ \text{m} = 100\ \text{m}]$$

$$E = 120\ \text{N}$$

$$MA = \frac{500\ \text{N}}{120\ \text{N}} = 4.17$$

181. A woman draws water from a well using a fixed pulley. The mass of the bucket and water together is 6.0 kg. The force applied by the woman is 70 N. Calculate the mechanical advantage. (Take $g = 10\ \text{ms}^{-2}$)

Ans : SQP 2011

Given, Load = weight of water,

$$L = 6.0 \times 10\ \text{N},$$

$$\text{Effort} = \text{Force applied} = E = 70\ \text{N}$$

Now, $$\text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{60}{70} = 0.86$$

182. A machine is operated by an effort of 80 N acting downward and moving through a downward displacement of 0.15 m. The load of mass 10 kg, is raised up by 10 cm. Calculate the M.A., V.R., work input, useful work output and efficiency. (Take $g = 10\ \text{ms}^{-2}$)

Ans : COMP 2020

Given, $E = 80\ \text{N},\ d_E = 0.15\ \text{m},\ g = 10\ \text{ms}^{-2}$

$$L = 10 \times 10 = 100\ \text{N},$$

$$d_L = 10\ \text{cm} = 0.10\ \text{m},$$

$$\text{M.A.} = ?,\ \text{V.R.} = 1,\ \text{work input} = ?,$$

$$\text{Work output} = ?$$

By definition, $$\text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{100}{80} = 1.25$$

$$\text{V.R.} = \frac{d_E}{d_L} = \frac{0.15}{0.10} = 1.5$$

$$\text{Work input} = E \times d_E = 80\ \text{N} \times 0.15\ \text{m}$$

$$= 8 \times 1.5 = 12\ \text{J}$$

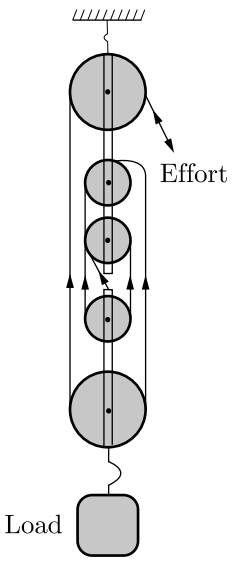
$$\text{Useful work output} = L \times d_L$$

$$= 100\ \text{N} \times 0.10\ \text{m} = 10\ \text{J}$$

$$\text{Efficiency, } \eta = \frac{\text{Output}}{\text{Input}} = \frac{10}{12}$$

$$= 0.833 = 83.3\%$$

183. The pulley system shown in figure is used to raise a 650 kgf object. What is the mechanical advantage and what force is exerted?



NODIA

(c) What is the power input to the machine ?
(d) If the efficiency of the machine is 75%, what is the power output ?
(e) What is the work done by machine in 4 seconds?

Ans : COMP 2008

(a) Force exerted by the falling weight = mg
$= 100 \times 10 = 1000\ \text{N}$

(b) Work done by the falling weight $= mg \times h$
$= 1000\ \text{N} \times 8\ \text{m} = 8000\ \text{J}$

(c) Power input to the machine $= \frac{W}{t}$
$= \frac{8000\ \text{J}}{4\ \text{s}} = 2000\ \text{W}$

(d) Power output$= \eta \times$ Power input
$= \frac{75}{100} \times 2000 = 1500\ \text{W}$

(e) Work done by the machine
= Power output × Time
$= 1500\ \text{W} \times 4\ \text{s} = 6000\ \text{J}$

193. A block and tackle with 5 pulleys is found to have a M.A. of 4 when a load of 5 N is raised by it. Calculate (a) the effort applied, (b) V.R., (c) efficiency and (d) the total resistance R due to friction.

Ans : SQP 2019

Number of pulleys in the block and tackle = 5

$$\text{M.A.} = 4,\ L = 5\,\text{N},\ E = ?$$

Total resistance, $R = ?,\ n = ?$

Now, we know that velocity ratio of a pully block and tackle is equal to the total number of pulleys.

$$\text{V.R.} = 5,\ \text{M.A.} = 4$$

$$\text{Percentage efficiency} = \frac{\text{M.R.}}{\text{V.R.}} \times 100$$

$$= \frac{4}{5} \times 100 = 80\%$$

Also, $\text{M.A.} = \frac{L}{E}$

$$E = \frac{L}{\text{M.A.}}$$

$$= \frac{5}{4} = 1.25\,\text{N}$$

Also, $L + R = \text{V.R.} \times E$

$$= 5 \times 1.25 = 6.25$$

$$R = 6.25 - L = 6.25 - 5$$

$$= 1.25\,\text{N}$$

194. The height of a new truck is 1.5 m. A drum of 200 kg mass is to be lifted on it using an inclined plane. The effort applied is 1500 N parallel to the plank and the force of friction is 250 N. Calculate: (a) the M.A., (b) V.R. and (c) η of the plank as a machine as an inclined plane (d) the length of the plank.

Ans : MAIN 2019

$$L = 200\ \text{kg wt.},$$

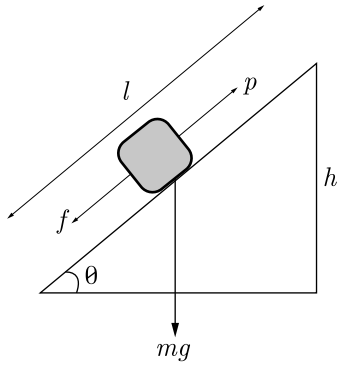
$$E = 1500\,\text{N},$$

$$\text{Resistance, } R = 250\,\text{N}$$

$$\text{M.A.} = \frac{L}{E}$$

$$= \frac{200 \times 10}{1500}$$

$$= \frac{4}{3} = 1.33$$



When the load is being lifted without acceleration

$$P = mg\sin\theta + F$$

$$1500 = 200 \times 10 \times \sin\theta + 250$$

$$2000\sin\theta = 1250$$

$$\sin\theta = \frac{1250}{2000} = 0.625$$

If V.R. is the velocity ratio of the inclined plane, then

$$\text{V.R.} = \frac{1}{\sin\theta} = \frac{2000}{1250} = 1.6$$

$$\%\ \eta \text{ is given by} = \frac{\text{M.A.}}{\text{V.R.}} \times 100$$

$$= \frac{1.333}{1.6} \times 100$$

$$= 83.33\%$$

Also, from the figure, $\frac{1}{\sin\theta} = \frac{l}{h}$, where l is the length of the inclined plane.

$$1.6 = \frac{l}{1.5}$$

$$l = 1.6 \times 1.5 = 2.4\ \text{m}$$

Downloaded from www.pdf.tube

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!

(i) $\text{M.A.} = \frac{L}{E}$, therefore,

$$\text{Effort} = \frac{L}{\text{M.A.}}$$
$$= \frac{200}{5} = 40 \text{ kgf}$$

(ii) Work output = Load × Displacement of load

$$= 2000 \text{ N} \times 20 \text{ m} = 40000 \text{ J}$$

Now, $\eta = \frac{\text{Work outpur}}{\text{Efficiency}} = \frac{40000}{0.8}$

$$= 50000 \text{ J}$$

188. In a single movable pulley system a load of 250 kgf is lifted by an effort of 150 kgf. Find the percentage efficiency of system.

Ans : COMP 2019

V.R. of single movable pulley = No. of supporting segments of string = 2

M.A. of single movable pulley $= \frac{L}{E} = \frac{250}{150} = \frac{5}{3}$

Therefore, efficiency is

$$\eta = \frac{\text{M.A.}}{\text{V.R.}}$$
$$= \frac{5}{3 \times 2} = \frac{5}{6}$$
$$= 0.833 = 83.3\%$$

or $0.833 \times 100 = 83.3\%$

189. A simple machine enables us to lift a load of 10000 N by the application of an effort of 500 N. However, when the point of application of the effort moves through 2.5 m, the load gets raised through 10 cm only. What are the values of the (i) M.A., (ii) V.R. and (iii) Efficiency of the machine?

Ans : SQP 2010

$$\text{Load} = 10000 \text{ N}, \text{ Effort} = 500 \text{ N},$$
$$d_E = 2.5 \text{ m}, \ d_L = 10 \text{ cm} = 0.1 \text{ m}$$

(i) $\text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{10000}{500} = 20$

(ii) $\text{V.R.} = \frac{d_E}{d_L} = \frac{2.5}{0.1} = 25$ and

(iii) $\eta = \frac{\text{M.A.}}{\text{V.R.}}$

$$= \frac{20}{25} = \frac{4}{5} = 0.8 = 80\%$$

190. A labourer uses a sloping wooden plank of length 2.0 in to push up a load of 600 N into the truck at a height of 0.8 m.

(i) What is the mechanical advantage of the sloping plank ?

(ii) How much effort is needed to push the load up into the truck ?

(iii) What assumption have you made in arriving at your answer in part (ii) above?

Ans : MAIN 2023

(i) $\text{M.A.} = \frac{\text{length}}{\text{height}} = \frac{2}{0.8} = 2.5$

(ii) $\text{Effort} = \frac{\text{Load}}{\text{M.A.}} = \frac{600}{2.5} = 240 \text{ N}$

(iii) The assumption made is that there is no friction between the plank and the moving body.

191. A pulley system has four pulleys in all and is 90% efficient. Calculate (i) M.A., (ii) Effort required to lift a load of 1000 N, (iii) Resistance due to movable parts of machine and friction.

Ans : SQP 2011

Given, V.R. = 4

$$\eta = 90\%$$
$$\text{M.A.} = \text{V.R.} \times \eta$$
$$= \frac{4 \times 90}{100} = 3.6$$
$$\text{M.A.} = \frac{\text{Load}}{\text{Effort}}$$
$$3.6 = \frac{1000}{\text{Effort}}$$
$$E = \frac{1000}{3.6} = \frac{10000}{36}$$
$$= \frac{2500}{9} = 277.7 \text{ N}$$
$$\text{V.R.} = \text{M.A.} + \frac{x}{E}$$
$$4 = 3.6 + \frac{x}{2500} \times 9$$
$$0.4 = \frac{9x}{2500}$$
$$9x = 1000$$
$$x = 111.1 \text{ N}$$

(where, $x =$ resistance due to movable parts of machine and friction).

192. A machine is driven by a 100 kg mass that falls 8 m on 4 s. It lifts a load of mass 500 kg vertically upwards.

(a) What is the force in newton exerted by the falling mass ?

(b) What is the work done by the 100 kg mass falling through 8 m ?

$$_1\mu_2 = \frac{1}{_2\mu_1}$$

5. LATERAL DISPLACEMENT

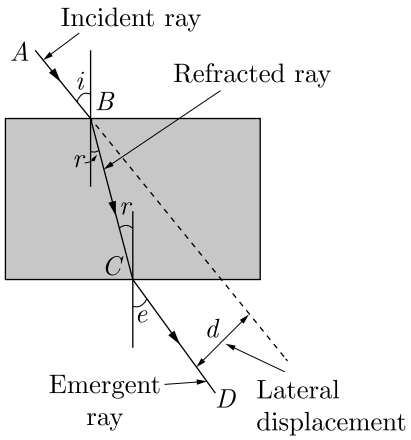
When the ray of light is incident obliquely on any glass surface, after refraction it is found that the emergent ray is parallel to the incident ray and the perpendicular separation between the incident ray produced and the emergent ray is called lateral displacement.

It depends on:

(i) the thickness of the glass block between the incident surface and the emergent surface.

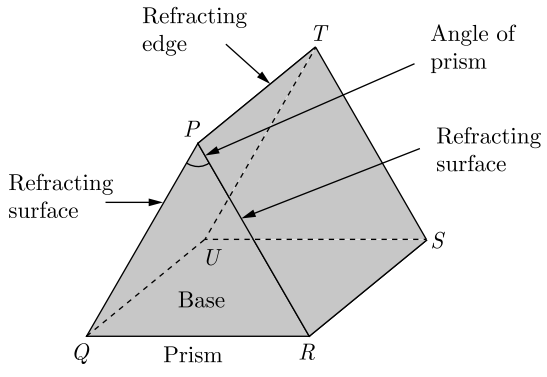
(ii) the angle of incidence.

For normal incidence, i.e. $\angle i = \angle r = 0$, the lateral displacement is zero.



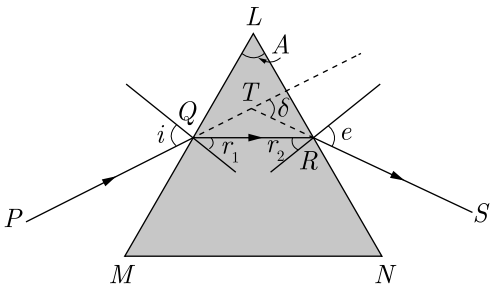
6. PRISM

A prism is a portion of transparent refracting medium bounded by three rectangular and two triangular faces. The angle between the refracting faces is called the angle of prism (A).



Principal section of prism is the section of the prism normal to the refracting edge, e.g., LMN

Download NODIA App for All Sample Papers PDFs



PQ = Incident ray

i = Angle of incidence

QR = Refracted ray

r_1, r_2 = Angles of refraction

RS = Emergent ray

e = Angle of emergence

δ = Angle of deviation

A = Angle of prism

δ_m = Angle of minimum deviation

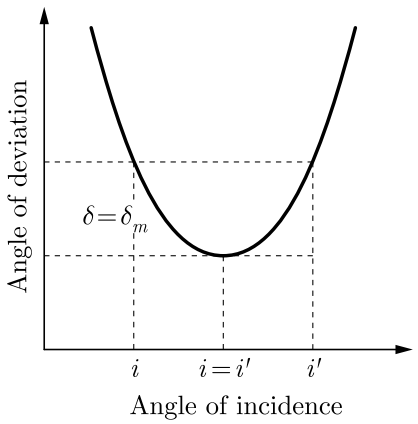
$$\delta = i + e - A$$

$$r_1, r_2 = A$$

$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

7. ANGLE OF DEVIATION

(i) Variation of angle of deviation (δ) with angle of incidence (i) is as follows :



(ii) Angle of deviation depends on :

(1) the angle of incidence

(2) the angle of the prism

(3) the material of the prism

(4) the wavelength of the light used.

(iii) At minimum deviation position i.e. δ_m :

Click Here to Buy book on Amazon

195. A pulley system has three pulleys. A load of 120 N is overcome by applying an effort of 120 N. Calculate the mechanical advantage and efficiency of this system.

Ans : MAIN 2016

Given, $L = 120\,\text{N},\ E = 50\,\text{N},$

$\text{M.A.} = ?,\ \eta = ?$

$$\text{M.A.} = \frac{L}{E} = \frac{120}{50} = 2.4$$

Velocity ratio is equal to the number of pulleys, hence

$$\eta = \frac{\text{M.A.}}{\text{V.R.}}$$

$$= \frac{2.4}{3} = 0.8$$

196. A pulley system has three pulleys. A load of 120 N is overcome by applying an effort of 50 N. Calculate the Mechanical Advantage and Efficiency of this system.

Ans : SQP 2016

Load, $L = 120\ \text{N},$

Effort, $E = 50\ \text{N},$

Mechanical advantage, MA =?,

Velocity ratio VR = 3,

Efficiency, $\eta = ?$

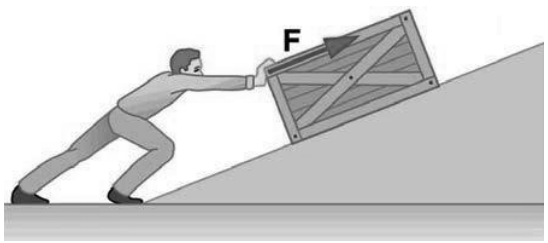
Mechanical advantage,

$$\text{MA} = \frac{\text{MA}}{\text{VR}} \times 100$$

$$= \frac{2.4}{3} \times 100 = 80\%$$

CASE BASED QUESTION

197. A coolie is pushing a box weighing 1500 N up an inclined plane 7.5 in long on to a platform, 2.5 m above the ground.

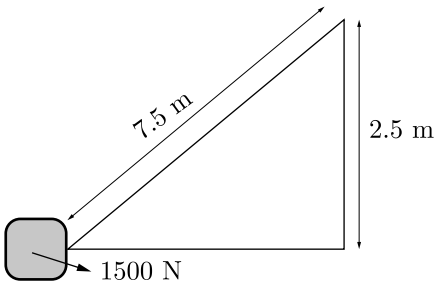


(i) Calculate the mechanical advantage of the inclined plane.

(ii) Calculate the effort applied by the coolie.

(iii) In actual practice, the coolie needs to apply more effort than what is calculated. Give one reason why you think the coolie needs to apply more effort.

Ans : COMP 2022



(i) $$\text{M.A.} = \frac{\text{Length}}{\text{Height}} = \frac{7.5}{2.5} = 3$$

(ii) $$\text{M.A.} = \frac{L}{E}$$

$$3 = \frac{1500}{E}$$

$$E = 500\,\text{N}$$

(iii) In actual practice due to friction etc. efficiency is not 100% and velocity ratio is more than mechanical advantage or output is less than work input. So, he needs to apply more effort than calculated.

198. A construction site worker needs to lift a heavy concrete block weighing 300 kg using a lever. The worker can apply a maximum effort of 100 kg. To achieve this, the worker uses a Class I lever where the distance from the fulcrum to the point where the effort is applied (effort arm) is 3 meters, and the distance from the fulcrum to the load (load arm) is 1 meter.

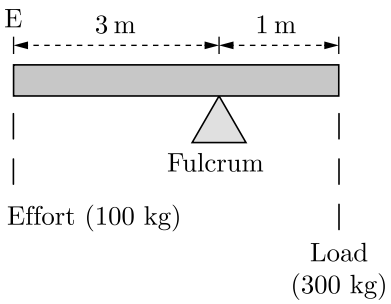


Illustration of a Class I lever where effort (E), load (L), and fulcrum (F) are shown.

(i) Calculate the mechanical advantage (MA) of the lever.

Downloaded from www.pdf.tube

(ii) Determine if the worker can lift the concrete block with the given lever setup.
(iii) Calculate the velocity ratio (VR) of the lever.
(iv) What is the efficiency (η) of the lever if it is an ideal machine?

Ans :

(i) The mechanical advantage (MA) of the lever is calculated using the formula:

$$\text{MA} = \frac{\text{Load}}{\text{Effort}}$$
$$= \frac{300\text{ kg}}{100\text{ kg}} = 3$$

(ii) $$\text{Effective Force} = \text{Effort} \times \text{MA}$$
$$= 100\text{ kg} \times 3 = 300\text{ kg}$$

Thus, the worker can lift the 300 kg concrete block with the lever.

(iii) $$\text{VR} = \frac{\text{Effort arm}}{\text{Load arm}}$$
$$= \frac{3\text{ m}}{1\text{ m}} = 3$$

(iv) For an ideal machine, the efficiency (η) is 100%. In practical terms, efficiency is given by:

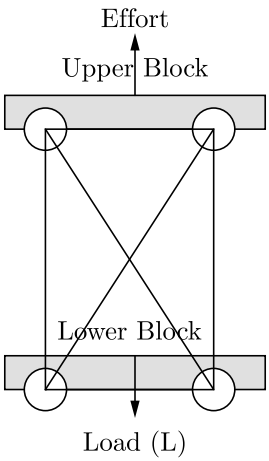
$$\eta = \frac{MA}{VR} \times 100\%$$

For this ideal lever system:

$$\eta = \frac{3}{3} \times 100 = 100\,\%$$

Therefore, the lever operates at 100% efficiency as an ideal machine.

199. Let's consider a block and tackle pulley system with 4 pulleys (2 in the upper block and 2 in the lower block) to illustrate the concepts.



(i) What is the mechanical advantage (MA) of the given block and tackle system if the weight of the pulleys is negligible?

NODIA

(ii) If the load (L) to be lifted is 200 N, what is the effort (E) required to lift the load using this block and tackle system?
(iii) What is the velocity ratio (VR) of the given block and tackle system?
(iv) If the efficiency (η) of the block and tackle system is 80%, what is the actual effort required to lift the 200 N load?

Ans :

(i) The mechanical advantage (MA) of the system is equal to the number of pulleys in the system. In this case, with 4 pulleys, the MA is 4.

$$\text{MA} = 4$$

(ii) The effort required (E) can be calculated using the mechanical advantage (MA).
Given that MA = 4,

$$E = \frac{L}{MA}$$
$$= \frac{200\text{ N}}{4} = 50\text{ N}$$

(iii) The velocity ratio (VR) is also equal to the number of pulleys in the system. For this system with 4 pulleys, the VR is 4.

$$\text{VR} = 4$$

(iv) The actual effort required considering the efficiency (η) can be calculated as

$$\eta = \frac{MA}{VR}$$

Given, $\eta = 0.8$ (or 80%)

$$\eta = \frac{MA}{VR}$$
$$0.8 = \frac{4}{VR}$$
$$\text{VR} = 4$$

The actual effort required (E_actual) considering the efficiency

$$\text{E_actual} = \frac{E}{\eta} = \frac{50\text{ N}}{0.8} = 62.5\text{ N}$$

200. You are an engineer tasked with designing a system to lift heavy loads using a combination of simple machines. The goal is to make the system as efficient and easy to use as possible. You have the following components at your disposal: levers, pulleys, and a block and tackle system.
(i) You decide to start with a lever system. You use a Class I lever where the effort arm is 2 meters and the load arm is 1 meter. If the load to be lifted is 200 N, calculate the effort required?

(ii) Next, you decide to use a single movable pulley to lift the same 200 N load. Calculate the mechanical advantage and the effort required to lift the load, assuming an ideal pulley system.

(iii) Now, you combine the lever system with the single movable pulley. Calculate the total mechanical advantage and the effort required to lift the 200 N load using this combined system.

(iv) Finally, you decide to implement a block and tackle system with 4 pulleys (2 fixed and 2 movable). Calculate the mechanical advantage, the velocity ratio, and the effort required to lift the 200 N load, assuming an ideal system.

Ans :

(i) For a Class I lever:
Mechanical Advantage (MA)

$$= \frac{\text{Load arm}}{\text{Effort arm}} = \frac{2}{1} = 2$$

The effort required (E) is given by

$$\text{Effort} = \frac{\text{Load}}{\text{MA}} = \frac{200\text{ N}}{2} = 100\text{ N}$$

(ii) For a single movable pulley:
Mechanical Advantage (MA) = 2
The effort required (E) is given by

$$\text{Effort} = \frac{\text{Load}}{\text{MA}}$$

$$= \frac{200\text{ N}}{2} = 100\text{ N}$$

(iii) The total mechanical advantage (MA) of the combined system is the product of the individual MAs

$$\text{Total MA} = \text{MA (lever)} \times \text{MA (pulley)}$$

$$= 2 \times 2 = 4$$

The effort required (E) is given by

$$\text{Effort} = \frac{\text{Load}}{\text{MA}}$$

$$= \frac{200\text{ N}}{4} = 50\text{ N}$$

(iv) For a block and tackle system with 4 pulleys
Mechanical Advantage (MA) = Number of pulleys = 4
The velocity ratio (VR) is equal to the mechanical advantage for an ideal system
Velocity Ratio (VR) = 4
The effort required (E) is given by

$$\text{Effort} = \frac{\text{Load}}{\text{MA}}$$

$$= \frac{200\text{ N}}{4} = 50\text{ N}$$

201. You are working on a project to design a simple lifting mechanism for a construction site. The mechanism needs to lift heavy loads efficiently using available simple machines. You have access to levers, different pulley systems, and a block and tackle setup.

(i) You start with a Class II lever. The effort arm is 3 meters and the load arm is 1 meter. If the load to be lifted is 300 N, calculate the effort required.

(ii) Next, you use a single fixed pulley to lift the same 300 N load. Calculate the mechanical advantage and the effort required to lift the load, assuming an ideal pulley system.

(iii) You then decide to use a combination of a Class III lever and a single movable pulley. The effort arm of the lever is 2 meters and the load arm is 4 meters. Calculate the total mechanical advantage and the effort required to lift the 300 N load using this combined system.

(iv) Finally, you decide to implement a block and tackle system with 6 pulleys (3 fixed and 3 movable). Calculate the mechanical advantage, the velocity ratio, and the effort required to lift the 300 N load, assuming an ideal system.

Ans :

(i) For a Class II lever:
Mechanical Advantage (MA)

$$= \frac{\text{Effort arm}}{\text{Load arm}}$$

$$= \frac{3}{1} = 3$$

The effort required (E) is given by

$$\text{Effort} = \frac{\text{Load}}{\text{MA}}$$

$$= \frac{300\text{ N}}{3} = 100\text{ N}$$

(ii) For a single fixed pulley:
Mechanical Advantage (MA) = 1
The effort required (E) is given by

$$\text{Effort} = \text{Load} = 300\text{ N}$$

(iii) For a Class III lever:
Mechanical Advantage (MA)

$$= \frac{\text{Effort arm}}{\text{Load arm}}$$

$$= \frac{2}{4} = 0.5$$

For a single movable pulley:
Mechanical Advantage (MA) = 2
The total mechanical advantage (MA) of

Click Here to Buy book on Amazon

the combined system is the product of the individual MAs:

$$\text{Total MA} = \text{MA (lever)} \times \text{MA (pulley)}$$

$$= 0.5 \times 2 = 1$$

The effort required (E) is given by

$$\text{Effort} = \frac{\text{Load}}{\text{Total MA}}$$

$$= \text{Load} = 300\ \text{N}$$

(iv) For a block and tackle system with 6 pulleys
Mechanical Advantage (MA) = Number of pulleys = 6
The velocity ratio (VR) is equal to the mechanical advantage for an ideal system
Velocity Ratio (VR) = 4
The effort required (E) is given by

$$\text{Effort} = \frac{\text{Load}}{\text{MA}}$$

$$= \frac{300\ \text{N}}{6} = 50\ \text{N}$$

NODIA

CHAPTER 4

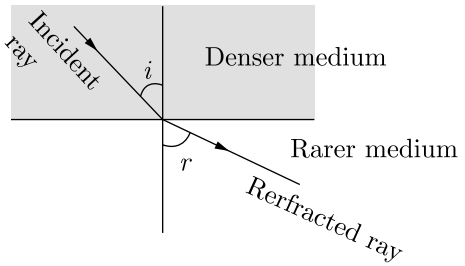
LIGHT

SUMMARY

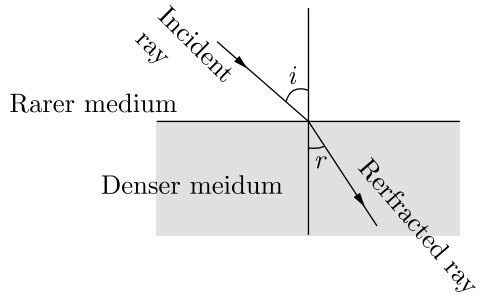
1. REFRACTION

When light passes from one medium to another medium, the phenomenon of change in the direction of path of light is called refraction.

(i) When a ray of light travels from a rarer medium to a denser medium, it bends towards the normal, i.e. $\angle i > \angle r$.



(ii) When a ray of light travels from a denser medium to a rarer medium, it bends away from the normal, i.e. $\angle i < \angle r$.



(iii) If the ray is incident normally on the surface separating the two media, it goes undeviated, i.e. $\angle i = 0$, $\angle r = 0$.

2. CAUSE OF REFRACTION

Light travels with different speeds in different media. In vacuum, light travels with speed $3 \times 10^8\ \text{m s}^{-1}$. In air, it travels with less speed. Speed of light further reduces in glass or water. Basic cause of refraction is change in the velocity of light in going from one medium to the other.

3. REFRACTIVE INDEX

Refractive index (μ) of a medium is the ratio of speed of light in vacuum to the speed of light in that medium.

$$\mu = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}};$$

$$\mu = \frac{c}{v}$$

Values of μ for some common substances

μ of water	μ of glass	μ of diamond
1.33	1.52	2.47

Refractive index of a medium depends on its nature, physical conditions and colour (or wavelength) of light ($\mu_v > \mu_r$).

$$\text{Velocity} = \text{Frequency} \times \text{Wavelength}$$

$$v = \nu\lambda$$

4. LAWS OF REFRACTION

Laws of refraction are as follows:

(i) The incident ray, the refracted ray and the normal at the point of incidence lie in the same plane.

(ii) The ratio of the sine of the angle of incidence and sine of the angle of refraction is equal to constant for the same pair of media. This constant ratio is called the refractive index of the second medium with respect to the first. It is represented by Greek letter μ (mew) or n. This law is called Snell's law in the honour of the name of the scientist Willibroad Snell who first formulated it in 1621.

If light travels from medium 1 to medium 2, then

$$\frac{\sin i}{\sin r} = {}_1\mu_2$$

where, ${}_1\mu_2$ is called the refractive index of medium 2 with respect to medium 1.

According to the principle of reversibility

Downloaded from www.pdf.tube

Ans : MAIN 2002

M.A. = number of segments holding the load

$= 5$

$\text{Load} = L = 650\ \text{kgf}$,

$\text{Effort} = E = ?$

We know, $\text{M.A.} = \dfrac{\text{Load}}{\text{Effort}}$

$\text{Effort} = \dfrac{\text{Load}}{\text{M.A.}} = \dfrac{650}{5} = 130\ \text{kgf}$

184. An effort of 10 N is applied at the free end of the string passing on a single movable pulley system with a load attached to it. The weight of the movable pulley is 3 N. The frictional forces are negligible.

(a) Calculate the mass of the load being raised.

(b) On a diagram of the pulley system with strings, mark the direction of the forces, effort E, tension in the strings T and the load L.

(c) Calculate the tension T in anyone segment of the string.

(d) Also, calculate V.R., M.A. and efficiency.

(Take $g = 10\ \text{ms}^{-2}$)

Ans : COMP 2013

Given, $E = 10\ \text{N}$, $W = 3\ \text{N}$, mass of load $= ?$,

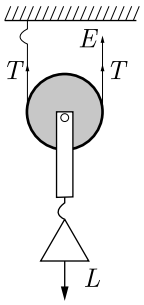
$T = ?$, V.R., M.A. and $\eta = ?$

(a) $E = T$, $L + W = 2\text{T} = 2\text{E}$;

$L = 2\,\text{E} - W = 20 - 3 = 17\ \text{N}$

$\text{Mass of the load} = \dfrac{17}{10} = 1.7\ \text{kg}$

(b)



(c) $T = E = 10\ \text{N}$

(d) $\text{V.R.} = \dfrac{d_E}{d_L} = \dfrac{x}{x/2} = 2$

$\text{M.A.} = \dfrac{L}{E} = \dfrac{17}{10} = 1.7$

and $\eta = \dfrac{\text{M}}{\text{V.R.}} = \dfrac{1.7}{2} = 0.85 = 85\%$

185. A worker is pushing a box weighing 1500 N up a ramp 6.00 m long onto a platform 1.50 m above the ground. What is the mechanical advantage and what is the effort applied?

Ans : SQP 2009

$\text{Load} = L = 1500\ \text{N}$,

$\text{Effort} = E = ?$,

$\text{Length of plane} = 6.00\ \text{m}$,

$\text{Height of plane} = 1.50\ \text{m}$

Now, $\text{M.A.} = \dfrac{\text{Length of plane}}{\text{Height of plane}}$

$= \dfrac{6.00}{1.50} = 4$

$\text{M.A.} = \dfrac{\text{Load}}{\text{Effort}}$

$= \dfrac{1500}{4} = 375\ \text{N}$

186. An effort of 6 kgf is applied on a machine through a displacement of 90 cm, when a load of 100 kgf moves through a distance of 4 cm. Calculate :

(i) Velocity ratio.

(ii) M.A.

(iii) % age efficiency of machine.

Ans : MAIN 2011

(i) $\text{V.R.} = \dfrac{\text{Distance through which effort moves}}{\text{Distance through which load moves}}$

$= \dfrac{90}{4} = 22.5$

(ii) $\text{M.A.} = \dfrac{\text{Load}}{\text{Effort}} = \dfrac{100}{6} = 16.66$

(iii) $\eta = \dfrac{\text{M.A.}}{\text{V.R.}} \times 100$

$= \dfrac{16.66}{22.5} \times 100 = 74\%$

187. The mechanical advantage of a machine is 5 and its efficiency is 80%. It is used to lift a load of 200 kgf to a height of 20 m. Calculate:

(i) the effort required, and

(ii) the work done on the machine ($g = 10\ \text{ms}^{-2}$).

Ans : SQP 2002

$\text{M.A.} = 5$,

$\text{Efficiency} = 80\% = 0.8$,

$\text{Load, } L = 200\ \text{kgf}$

$= 200 \times 10\ \text{N} = 2000\ \text{N}$

$d_L = 20\ \text{m}$

NODIA

(1) Angle of incidence (i) = Angle of emergence (e)
(2) Angle of refraction (r_1) = Angle of refraction (r_2)
(3) The incident ray PQ and the emergent ray RS are symmetrically placed with respect to the prism.
(4) The refracted ray inside the prism is parallel to the base of the prism.

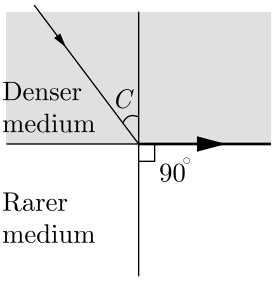
8. REAL AND APPARENT DEPTH

Real and apparent depth of a tank is given by

$$_r\mu_d = \frac{\text{Real depth}}{\text{Apparent depth}}$$

9. CRITICAL ANGLE

Critical angle for a pair of media in contact is the angle of incidence in the denser medium corresponding to which angle of refraction in the rarer medium is 90°. It is represented by C.



$$_d\mu_r = \frac{\sin i}{\sin r}$$

when, $i = C,\ r = 90^\circ$

$$_d\mu_r = \frac{\sin C}{\sin 90^\circ}$$

$$_d\mu_r = \sin C \qquad \{\sin 90^\circ = 1\}$$

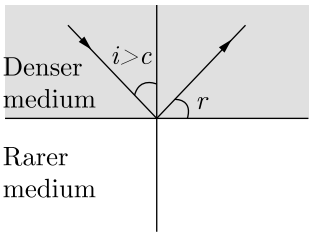
$$_d\mu_r = \frac{1}{\sin C} \qquad \left\{_d\mu_r = \frac{1}{_r\mu_d}\right\}$$

Where subscript r-rarer medium, d-denser medium.

10. TOTAL INTERNAL REFLECTION

Total internal reflection is the phenomenon due to which a ray of light travelling from optically denser medium to optically rarer medium gets reflected back into the optically denser medium at the surface of separation.

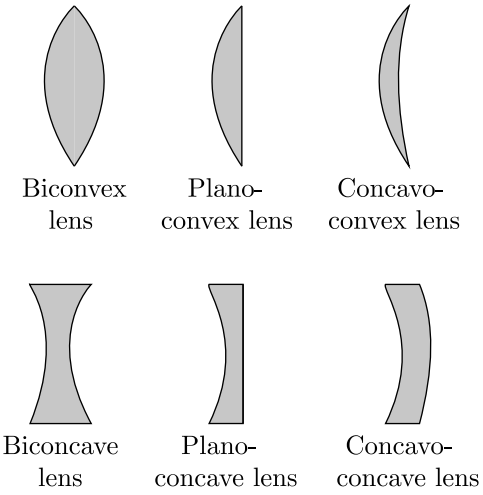
FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP



Essential conditions for total internal reflection are as follows:
(i) Incident ray must travel from optically denser medium to optically rarer medium.
(ii) The angle of incidence at the surface of separation between the two media must be greater than the critical angle for this pair of media.

11. LENS

Lens is a portion of a transparent refracting medium bounded by one or two spherical surfaces viz. convex lens (converging lens) and concave lens (diverging lens)



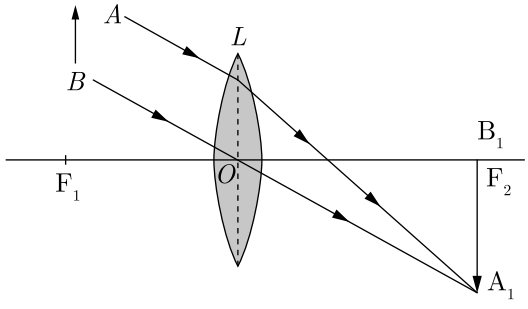
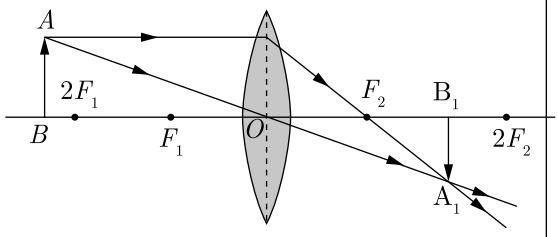
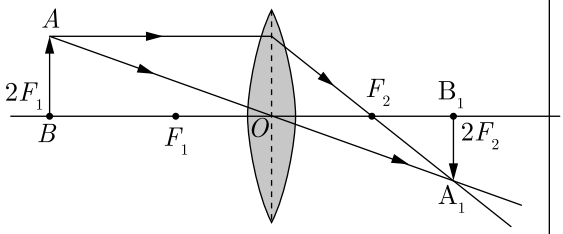
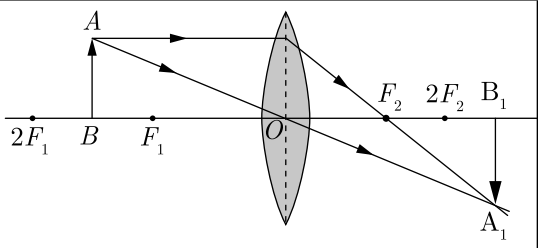
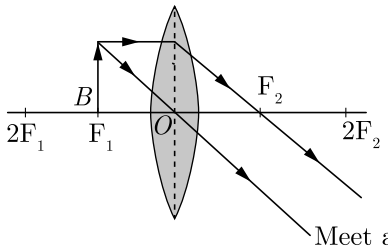
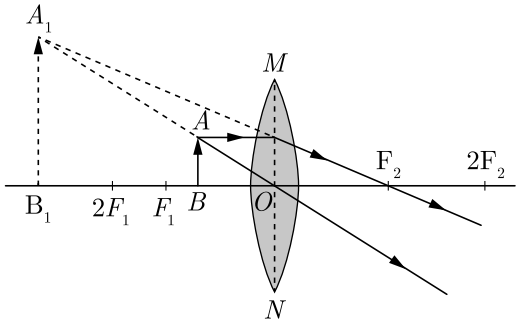
11.1 Convex and Concave Lens

Convex lens is thicker in the middle than at the edges. It converges the parallel beam of light incident on the lens after refraction. Therefore, it is also known as converging lens.

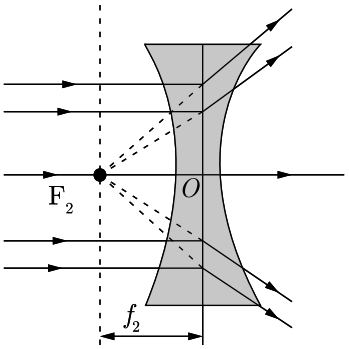
Concave lens is thinner in the middle than at the edges. It diverges the incident parallel beam of light on the lens after refraction. Therefore, it is also known as diverging lens.

Converging/diverging action of convex/ concave lens can be shown by considering the lens to be made up of large number of prisms as shown in the figures.

Click Here to Buy book on Amazon

	Position of the object O	**Position of the image I**	**Nature and size of the image**	**Ray-diagram**
1.	At infinity	At focus F_2	Real, inverted and highly diminished	
2.	Beyond $2F_1$	Between F_2 and $2F_2$	Real, inverted and diminished	
3.	At $2F_1$	At $2F_2$	Real, inverted and of same size	
4.	Between F_1 and $2F_1$	Beyond $2F_2$	Real, inverted and enlarged	
5.	At focus F_1	At infinity	Real, inverted and highly enlarged	
6.	Between F_1 and optical centre O	On the same side of the lens	Virtual, erect and enlarged	

NODIA



(b)

(v) Focal length is the distance between the optical centre and the focus.

12. RULES FOR OBTAINING IMAGES FORMED BY LENSES (CONVEX OR CONCAVE)

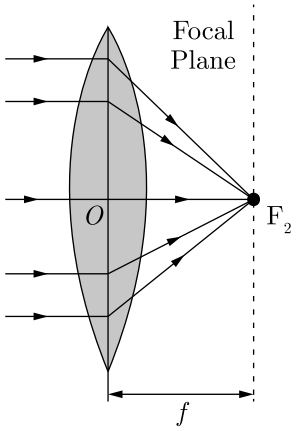
(i) An incident ray diverging through the first principal focus (in a convex lens) or appearing to converge at first principal focus (in a concave lens) emerges parallel to the principal axis after refraction.

(ii) An incident ray passing through the optical centre passes through the lens without deviation after refraction.

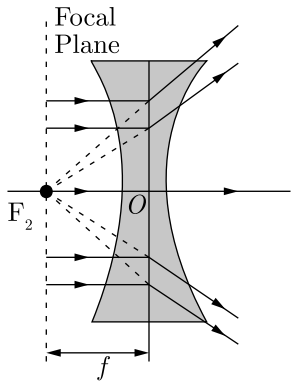
(iii) An incident ray parallel to the principal axis after refraction converges (in a convex lens) or appears to diverge (in a concave lens) through the second focus.

A convex lens can form a real as well as a virtual image but concave lens always forms a virtual, erect and smaller image.

Real image is formed by the actual intersection of rays whereas a virtual image is formed by the apparent intersection of rays when the rays are produced in backward direction.



(a)



(b)

13. NEW CARTESIAN SIGN CONVENTION

New Cartesian sign convention have following points :

(i) Light is incident on the lens from the left hand side.

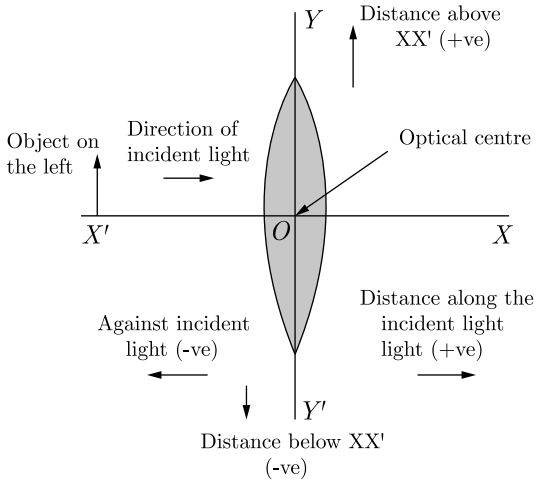
(ii) All distances are measured from the optical centre of the lens taken as origin and principal axis of the lens lines along XX'.

(iii) The distances taken in the direction of the incident light are taken as positive.

(iv) The distances taken in a direction opposite to the incident light are taken as negative.

(v) Heights or distances measured upward and normal to the principal axis are taken as positive while downward distances are taken as negative.

NODIA



Position and nature of image formed by a convex (converging) lens for different positions of object :

$$= \frac{3-1}{60}$$

$$= +30 \text{ cm}$$

Thus (b) is correct option.

(iv) An object is placed in front of this lens at a distance of 60 cm, then the magnification of the image is

(a) 0.25 (b) 1.25
(c) 0.5 (d) 1

Ans : SEM-I 2021

Object distance $= -60$ cm

Image distance $= +30$ cm

Magnification, $m = -\frac{v}{u}$

$$= +\frac{30}{60} = 0.5$$

Thus (c) is correct option.

12. The wavelength range of visible light is
(a) 40 nm to 80 nm
(b) 4000 nm to 8000 nm
(c) 4 nm to 8 nm
(d) 400 nm to 800 nm

Ans : SEM-I 2021

The range of wavelength for visible light is (400 − 800) nm.
Thus (d) is correct option.

13. The deviation produced by an equilateral prism does not depend on the
(a) angle of incidence
(b) size of the prism
(c) material of the prism
(d) colour of light used

Ans : SEM-I 2021

In an equilateral prism, the deviation produced does not depend on the size of the prism.
Thus (b) is correct option.

14. The colour of white light which is deviated least by a prism is
(a) green (b) yellow
(c) red (d) violet

Ans : SEM-I 2021

Red colour of white light deviates least by a prism as it has longer wavelength.
Thus (c) is correct option.

15. When white light is dispersed by a prism, compared with blue light, the red light is
(a) slowed down less and refracted more
(b) slowed down more and refracted less
(c) slowed down less and refracted less
(d) slowed down more and refracted more

Ans : MAIN 2000

As, $\lambda_{red} > \lambda_{blue}$

and $v = \nu\lambda$ (v is same for red and blue)

Then, $v_{red} > v_{blue}$,

So, red light is slowed down less and refracted less.
Thus (c) is correct option.

16. Which is not a source of ultraviolet radiations ?
(a) Sun (b) Arc lamp
(c) Star (d) Electric heater

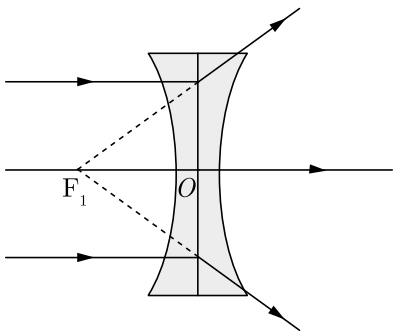
Ans : SQP 2011

Thus (d) is correct option.

17. When the object is at infinity, what is the nature of image formed by concave lens ?
(a) Real, inverted, enlarged
(b) Virtual, erect, diminished
(c) Real, inverted, same size
(d) Virtual, erect, enlarged

Ans : COMP 2006

When an object is at infinity, the nature of image formed by concave lens is virtual, erect and highly diminished.



Thus (b) is correct option.

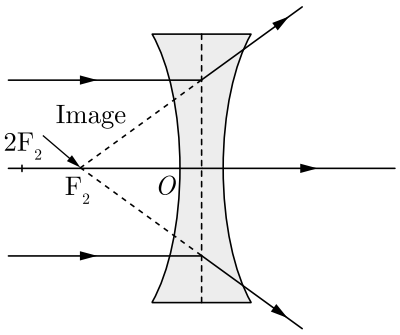
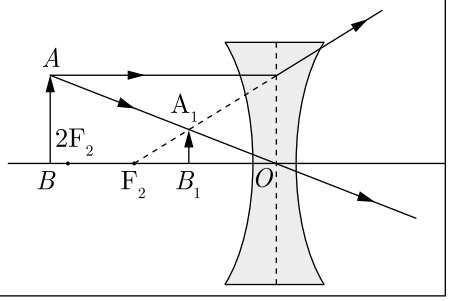
18. If two convex lenses are in contact with each other,
(a) the diverging power increases
(b) the converging power decreases
(c) the converging power increases
(d) the diverging power decreases

Ans : SQP 2016

If two convex lenses are in contact with each

Downloaded from www.pdf.tube

Position and nature of image formed by a concave (diverging) lens for different positions of object :

	Position of the object O	**Position of the image I**	**Nature and size of the image**	**Ray-diagram**
1.	At infinity	At focus F_2	Virtual, erect and highly diminished (point sized)	
2.	Anywhere between infinity and optical centre	Between focus and optical centre	Virtual, erect and smaller than the object	

14. TERMS RELATED TO LENS

(i) Thin lens formula is $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

Where, u and v are object and image distances respectively and f is the focal length of the lens. Focal length of a lens is greater than zero for a converging lens and less than zero for a diverging lens.

(ii) Magnification (m) produced by a lens is defined as the ratio of the size of the image to that of the object. The size of the object h_o is always taken to be positive, but image size h_i is taken as positive for an erect image and negative for an inverted image.

$$\text{Magnification}, (m)=\frac{h_i}{h_o}=\frac{v}{u}$$

Thus, m is positive for erect and virtual image formed by a convex or a concave lens and m is negative for an inverted and a real image.

(iii) Power of a lens is the reciprocal of its focal length where focal length is measured in metre.

$$P=\frac{1}{f(\text{metre})}$$

Its unit is dioptre.

15. SIMPLE MICROSCOPE

Magnifying glass or simple microscope is an optical instrument used to magnify the size of very small objects that are too small to be seen by naked eye.

16. HUMAN EYE

Least distance of distinct vision is the distance of nearest point up to which the normal human eye can see distinctly without strain. It is 25 cm for normal human eye.

Power of accommodation is the ability, of the eye-lens to see the objects at different distances by changing its focal length.

Persistence of vision is time for which the impression of image persists upon retina upto $\left(\frac{1}{16}\right)^{\text{th}}$ of a second after the object has been removed.

17. SPECTRUM

Dispersion is the phenomenon of splitting of white light after passing through a prism into its constituent colours.

Spectrum is the sequence of the colours obtained after dispersion of white light viz. VIBGYOR.

Pure spectrum has sharp well defined boundaries of various bands of colours which do

NODIA

not merge into each other.

Impure spectrum has no sharp well defined boundaries of various bands of colours. The colours are merged into each other.

A prism deviates as well as disperses a beam of white light incident on it. The red colour suffers the least deviation whereas the violet colour suffers the maximum deviation as $\mu_v > \mu_r$. This is why the violet colour is at the lower end and the red colour is at the upper end of the spectrum.

Angular dispersion produced by a prism for white light is the difference in the angles of deviation of two extreme colours of the spectrum violet and red colours, i.e. $\delta_v - \delta_r$.

Angular dispersion produced by a prism depends upon (i) angle of prism and (ii) nature of the material of the prism.

The cause of dispersion is the difference in deviations of different colours (wavelength) due to difference in their speeds and refractive indices.

The dispersive power of a prism is the ratio of angular dispersion to the mean deviation produced by the prism, i.e. $\omega = \frac{\delta_v - \delta_r}{\delta}$

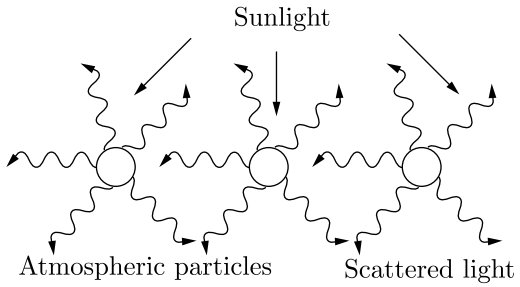
It depends only on the nature of the material of the prism.

Monochromatic light consists of only one colour (or wavelength).

Polychromatic light consists of many colours each having its characteristic wavelength. White light is polychromatic light.

18. SCATTERING OF LIGHT

Scattering means the spreading out of a beam of radiation as it passes through matter with reduced energy moving in the original direction. Depending on the circumstances, scattering can follow any combination of following processes on interacting with matter particles viz. reflection, absorption and reradiation. Sunlight travelling through the earth's atmosphere (clouds, water droplets and dust) changes its direction by the atmospheric particles. This is called scattering.



19. RAYLEIGH'S SCATTERING LAW

According to Rayleigh's Scattering Law, the amount of scattering is inversely proportional to the fourth power of the wavelength.

$$\text{Amount of scattering} \propto \frac{1}{\lambda^4}$$

Light of shorter wavelengths (or high frequencies) is scattered more than light of longer wavelengths (or low frequencies).

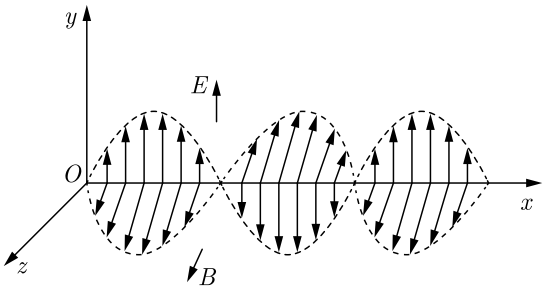
Blue Colour of Sky, Red Colour of Sun during Sunset and Sunrise and White Colour of Clouds are all due to scattering of light.

20. ELECTROMAGNETIC WAVES

According to Maxwell, the electromagnetic waves are those in which time varying electric and magnetic field vectors are perpendicular to each other as well as perpendicular to the direction of propagation of wave.

Electromagnetic waves :

1. are produced by accelerated or oscillating charge.
2. do not require any material medium for propagation.
3. travel in vacuum with the speed of light (3×10^8 m s^{-1}).
4. are transverse in nature.
5. are uncharged and this is why not deflected by electric and magnetic fields.
6. suffer reflection, refraction, diffraction etc.



7. Electromagnetic spectrum is the orderly distribution of electromagnetic radiation according to their wavelength or frequency.
8. Invisible spectrum is the region of the spectrum which does not excite retina and hence is not visible.

NO NEED TO PURCHASE SAMPLE PAPERS
Download India's Best 20 Sample Papers
DOWNLOAD NODIA APP
Every School conduct Pre-Board
From These Sample Papers

Click Here to Buy book on Amazon

MULTIPLE CHOICE QUESTION

NODIA

1. An endoscope uses optic fiber to transmit high resolution images of internal organs without loss of information. The principle of light that is used by the optic fiber is based on:
(a) refraction
(b) reflection
(c) scattering
(d) total internal reflection.

Ans : SQP 2025

Total internal reflection is the principle that allows light to pass through the core of an optical fiber by continually reflecting off the fiber's interior walls depending on the angle at which it strikes those walls.
Thus (d) is correct option.

2. White light is dispersed by a prism. Inside the prism, compared to the blue light, the red light
(a) slows down less and refracts more
(b) slows down more and refracts less
(c) slows down more and refracts more
(d) slows down less and refracts less

Ans : SQP 2025

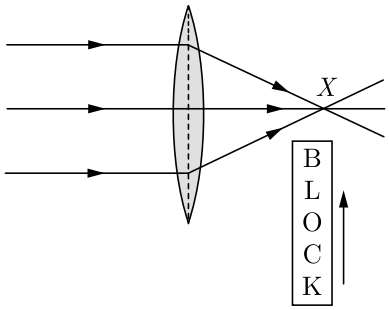
When white light enters a prism, the blue light is bentmore than the red, because blue light has a shorter wavelength and it refract more than the longer wavelength red light.
Thus (d) is correct option.

3. A convex lens has focal length 12 cm with an object at a distance of 20 cm in front of the lens. He obtains a blurred image on the screen placed at a distance of 23 cm in front of the lens. In order to obtain the clear image, he has to move the screen
(a) towards the lens.
(b) away from the lens.
(c) to a position very far away from the lens.
(d) either towards or away from the lens.

Ans : SQP 2025

In order to obtain the clear image, he has to move the screen away from the lens or towards to screen.
Thus (b) is correct option.

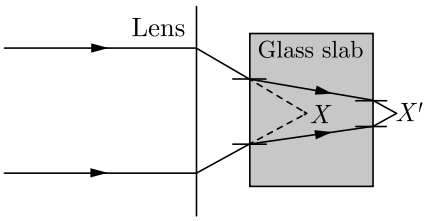
4. A block of glass is pushed into the path of the light as shown below. Then the converging point X will



(a) Move away from the slab
(b) Move towards the slab
(c) Not shift
(d) Move towards the left side of the lens

Ans : MAIN 2024

The light passing through glass slab will bend towards the normal and after coming out in the air, the light will converge out at a point away from the glass slab.



Thus (a) is correct option.

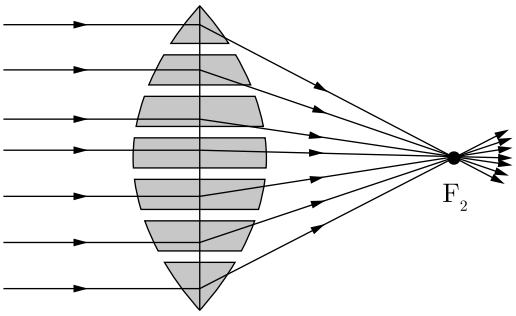
5. Linear magnification(m) produced by a concave lens is
(a) $m < 1$ (b) $m > 1$
(c) $m = 1$ (d) $m = 2$

Ans : MAIN 2024

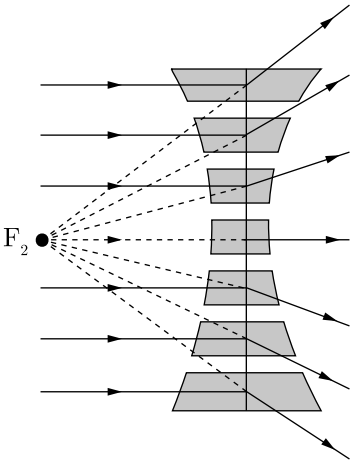
Concave lens always produces virtual, erect image, smaller than the object. Magnification refers to the ratio of the height of an image to the height of an object. Hence, the magnification is less than 1.
Thus (a) is correct option.

6. The refractive index of a diamond is 2.4. It means that,
(a) the speed of light in vacuum is equal to $\frac{1}{2.4}$ times the speed of light in diamond
(b) the speed of light in diamond is 2.4 times the speed of light in vacuum
(c) the speed of light in vacuum is 2.4 times the speed of light in diamond
(d) the wavelength of light in diamond is 2.4 times the wavelength of light in vacuum

Ans : SEM-I 2021



Converging action of a convex lens

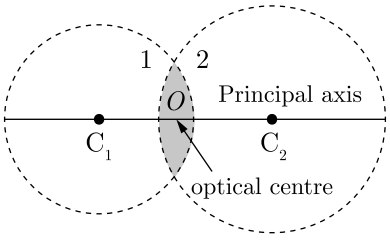


Diverging action of a concave lens

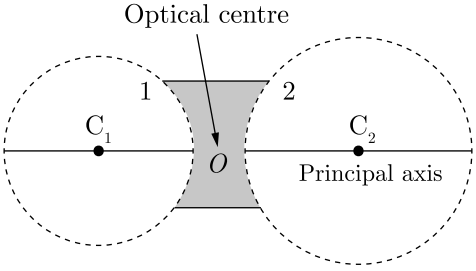
11.2 Terms Related to Lens

Some important terms related to lens are as follows :

(i) Principal axis is the straight line passing through the centre of curvature of the two surfaces of a lens.

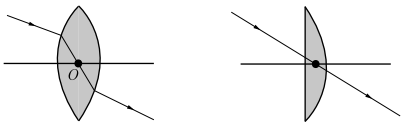


Convex lens



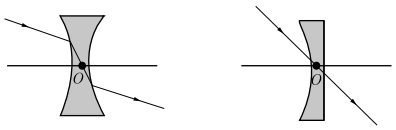
Concave lens

(ii) Optical centre is the point lying on the principal axis of a lens so that a ray passing through it emerges parallel to the direction of the incident ray, i.e., the emergent ray is parallel to the original direction of the incident ray. But for thin lens, optical centre is a point through which the ray passes undeviated.



Thick lens Thin lens

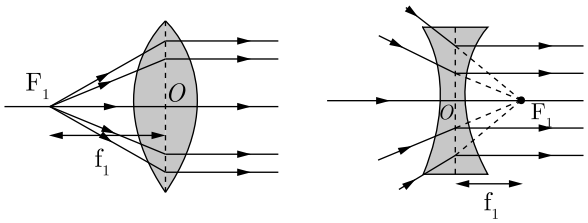
(Convex lens)



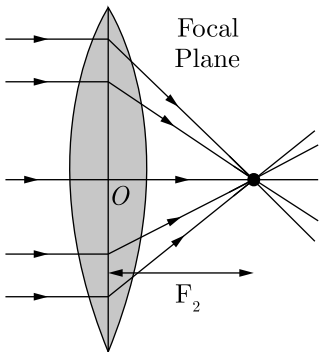
Thick lens Thin lens

(Concave lens)

(iii) First principal focus is a point on the principal axis such that rays coming from it (convex lens) or appear to meet at it (concave lens) become parallel to the principal axis after refraction.



(iv) Second principal focus is a point on the principal axis at which the rays incident on the lens parallel to the principal axis after refraction converges (in convex lens) or appear to diverge (in concave lens).



(a)

Downloaded from www.pdf.tube

9. The ratio of velocities of light of wavelength 400 nm and 800 nm in a vacuum is

(a) 1 : 1 (b) 1 : 2
(c) 2 : 1 (d) 1 : 3

Ans : SEM-I 2021

Since light is an *EM* wave and it is the property of all electromagnetic waves that they travel with same speed equal to 3×10^8 m/s in vacuum.
So, ratio of velocities of light having wavelength 400 nm and 800 nm in vacuum is 1 : 1.
Thus (a) is correct option.

10. An object of height 10 cm is placed in front of a concave lens of focal length 20 cm, at a distance of 25 cm from the lens. Is it possible to capture this image on a screen? Select a correct option from the following.

(a) Yes, as the image formed will be real.
(b) Yes, as the image formed will be erect.
(c) No, as the image formed will be virtual.
(d) No, as the image formed will be inverted.

Ans : COMP 2020

object size, $h_i = 10$ cm

Object distance, $u = -25$ cm

Focal length, $f = -20$ cm

By lens formula,

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} + \frac{1}{25} = \frac{-1}{20}$$

$$\frac{1}{v} = \frac{-1}{25} - \frac{1}{20}$$

$$= \frac{-4-5}{100} = \frac{-9}{100}$$

$$v = \frac{-100}{9} \text{ cm}$$

$$= -11.11 \text{ cm}$$

Image will form at 11 cm in front of lens.

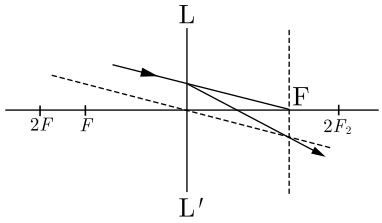
Magnification, $m = \frac{h_{\text{image}}}{h_{\text{object}}} = \frac{-v}{u}$

$$h_{\text{image}} = \frac{-(-11.11)}{25} \times 10$$

$$= 4.44 \text{ cm}$$

Image formed will be virtual and not possible to capture on a screen.
Thus (c) is correct option.

11. Observe the diagram which shows the path of an incident ray through an optical plane LL' of a lens. The focal length of the lens in 20 cm.



(i) If an object is placed at a distance of 30 cm in front of this lens, then the image will be
(a) virtual
(b) diminished and inverted
(c) diminished
(d) real and magnified

Ans : SEM-I 2021

Focal length, $f = +20$ cm

Object distance, $u = -30$ cm

Using lens formula, $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$$

$$= +\frac{1}{20} - \frac{1}{30}$$

$$v = +60 \text{ cm}$$

Image formed will be equal and magnified.
Thus (d) is correct option.

(ii) This type of lens can be used
(a) to correct hypermetropia
(b) to correct myopia
(c) to diverge light
(d) in the front door peepholes

Ans : SEM-I 2021

As, it a type of convex lens. So, it is used to correct hypermetropia.
Thus (a) is correct option.

(iii) An object is placed in front of this lens at a distance of 60 cm, then the image distance from the lens with proper sign convention is
(a) +60 cm (b) +30 cm
(c) −30 cm (d) +15 cm

Ans : SEM-I 2021

Given, $u = -60$ cm

$f = +20$ cm

Using lens formula,

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$= \frac{1}{f} + \frac{1}{u}$$

$$= \frac{1}{20} - \frac{1}{60}$$

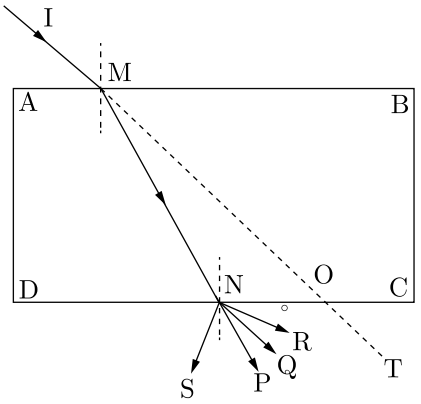
$$\text{Refractive index} = \frac{\text{speed of light in air}}{\text{speed of light in medium}}$$

So, speed of light in vacuum

= 2.4 times speed of light in diamond

Thus (c) is correct option.

7. A ray of light IM is incident on a glass slab $ABCD$ as shown in the figure. The emergent ray for this incident ray is

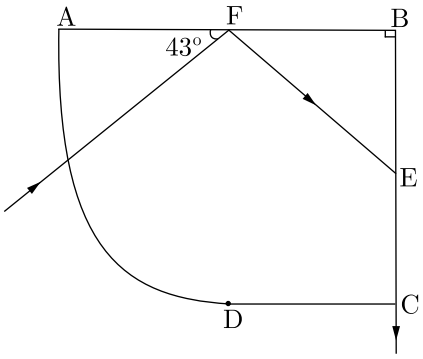


(a) NQ (b) NR
(c) NP (d) NS

Ans : SEM-I 2021

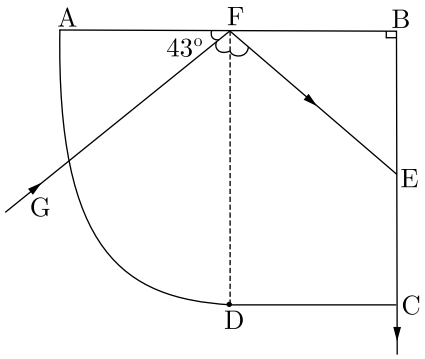
Here, the emergent ray will be away from the normal but is parallel to the incident ray.
So, NQ will be the emergent ray.
Thus (a) is correct option.

8. A ray of light travelling from air into a glass material as shown below. Answer the questions that follow.



(i) The angle of incidence at the surface AB is
(a) 43° (b) 47°
(c) 90° (d) 0°

Ans : SEM-I 2021



By using law of reflection,

angle of incidence = angle of reflection

$$\angle GFD = 90^\circ - 43^\circ$$

$$\angle FGD = 47^\circ$$

$$\angle GFD = \angle i = 47^\circ$$

Thus (b) is correct option.

(ii) Select a correct statement from the following:
(a) The speed of light at the curved surface AD does not change while entering the block.
(b) The ray at the surface AD is not traveling along the radius of the curved part.
(c) The ray at the surface AD is traveling along the radius of the curved part.
(d) Light never refracts when it enters a curved surface.

Ans : SEM-I 2021

Thus (c) is correct option.

(iii) The angle of incidence on the surface BC is
(a) 43° (b) 47°
(c) 90° (d) 0°

Ans : SEM-I 2021

The angle of incidence on surface BC is given by using law of reflection.

angle of incidence = angle of reflection

$$\angle AFG = \angle BFE = 43^\circ$$

So, angle of incidence on surface $BC = 43^\circ$
Thus (a) is correct option.

(iv) The critical angle of this material of glass is
(a) 47° (b) 43°
(c) 42° (d) 45°

Ans : SEM-I 2021

Critical angle of the this glass

$$\theta_c = 90^\circ - 43^\circ$$

$$= 47^\circ$$

Thus (a) is correct option.

Click Here to Buy book on Amazon

other, the equivalent focal length (f) and power of the combination (P) can be calculated as

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} \text{ and } P = P_1 + P_2$$

It increases the sharpness of image and converging power.

Thus (c) is correct option.

19. Violet, green, red and yellow are the four colours formed on a white screen when a polychromatic light is dispersed. The arrangement of colours in the decreasing order of wave lengths is :

(a) red, yellow, green and violet

(b) violet, green, yellow and red

(c) green, red, yellow and violet

(d) violet, green, red and yellow

Ans : COMP 2011

The arrangement of colours in the decreasing order of wavelengths is red, yellow, green and violet.

Thus (a) is correct option.

20. A needle placed 45 cm from a lens forms an image on a screen placed 90 cm on the other side of the lens. What is the power of the lens ?

(a) + 10 D (b) + 3.33 D

(c) − 10 D (d) − 3.33 D

Ans : SQP 2020

Given, $u = -45$ cm

Applying lens formula,

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{90} - \frac{1}{(-45)} = \frac{1}{f}$$

$$\frac{1}{90} + \frac{1}{45} = \frac{1}{f}$$

$$\frac{1+2}{90} = \frac{1}{f}$$

$$f = \frac{90}{3} = 30 \text{ cm}$$

$$\text{Power of lens, } P = \frac{1}{f} = \frac{100}{30} \text{ D}$$

$$= 3.33 \text{ D}$$

Thus (b) is correct option.

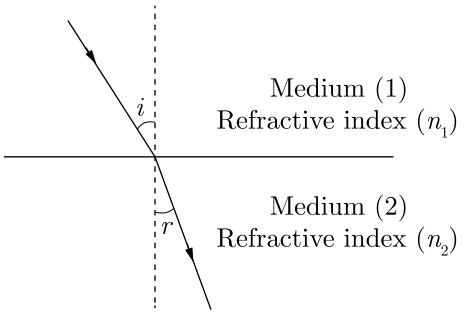
21. A ray of light travels from a medium of refractive index n_1 to a medium of refractive index n_2. If angle of incidence is i and angle of refraction is r , then $\frac{\sin i}{\sin r}$ is equal to

(a) $\frac{n_2}{n_1}$ (b) $\frac{n_1}{n_2}$

(c) n_1 (d) n_2

Ans : MAIN 2012

According to Snell's law,



$$n_1 \times \sin i = n_2 \times \sin r$$

Hence, $$\frac{\sin i}{\sin r} = \frac{n_2}{n_1}$$

Thus (a) is correct option.

22. The image when obtained from a concave lens of focal length f is magnified up to n times the size of the object. What is the distance of the object from the lens ?

(a) $\left(1 - \frac{1}{n}\right)f$ (b) $\left(1 + \frac{1}{n}\right)f$

(c) $\left(\frac{1-n}{n}\right)f$ (d) $\left(\frac{1+n}{n}\right)f$

Ans : COMP 2023

Using the lens formula,

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{u}{v} - 1 = \frac{u}{f} \quad \text{...(i)}$$

Given, $$m = \frac{v}{u} = n$$

Substituting the above values in eq. (i), we get

$$\left(\frac{1}{n} - 1\right) = \frac{u}{f}$$

$$u = \left(\frac{1-n}{n}\right)f$$

Thus (c) is correct option.

23. A convex lens can be regarded as a set of prisms and a glass slab, such that refracting angle of the prisms

(a) continuously increases in outward direction

(b) remains same in outward direction

(c) continuously decreases in outward direction

(d) none of these

Ans : SQP 2010

Downloaded from www.pdf.tube

$$\frac{1}{f} = \frac{5}{24}$$

$$f = \frac{24}{5} = 4.8 \text{ cm}$$

Thus (d) is correct option.

29. When an equilateral prism is in minimum deviation position the angle of incidence is :
(a) smaller than the angle of emergence
(b) equal to the angle of emergence
(c) greater than the angle of emergence
(d) none of these

Ans : SQP 2014

When an equilateral prism is in a minimum deviation position the angle of incidence is equal to the angle of emergence.
Thus (b) is correct option.

30. A converging lens has a focal length 40 cm. Calculate its power.
(a) − 2.5 D (b) + 2.5 D
(c) − 1.5 D (d) + 1.5 D

Ans : COMP 2018

Converging lens means convex lens has focal length + 40

$$f = 40 \text{ cm} = \frac{40}{100} \text{ m}$$

$$\text{Hence, Power of lens} = \frac{1}{f(\text{in metres})}$$

$$P = \frac{100}{40} = +2.5 \text{ D}$$

Thus (b) is correct option.

31. A stone placed at the bottom of a water tank appears raised by 80 cm. If the refractive index of water is 4/3, find the actual depth of water in the tank ?
(a) 320 cm (b) 150 cm
(c) 250 cm (d) 50 cm

Ans : MAIN 2004

Let the stone is at actual depth of x cm.

$$\text{Hence, observed depth} = (x - 80) \text{ cm}$$

$$\text{Refractive index} = \frac{\text{Actual depth}}{\text{observed depth}}$$

$$\frac{4}{3} = \frac{x}{x - 80}$$

$$4(x - 80) = 3x$$

$$4x - 3x = 320$$

$$\text{Actual depth, } x = 320 \text{ cm}$$

Thus (a) is correct option.

32. The critical angle for a material X is 45°. The total internal reflection will take place, if the angle of incidence in the denser medium is :
(a) less than 45°
(b) less than 45°, but not zero degree
(c) 90°
(d) more than 45°, but not 90°

Ans : SQP 2000

For total internal reflection the angle of incidence must be greater than the critical angle and less then 90 degree.
Thus (d) is correct option.

33. The angle of refraction in a glass block of refractive index 1.5 is 19°. Calculate the angle of incidence.
(a) 4.5 sin 19 (b) 2.5 sin 19
(c) 3.5 sin 19 (d) 1.5 sin 19

Ans : MAIN 2009

$$\text{Refractive index of glass} = \frac{\sin i}{\sin r}$$

$$1.5 = \frac{\sin i}{\sin 19^\circ}$$

$$\sin i = 1.5 \sin 19$$

Thus (d) is correct option.

34. The highest refractive index is of :
(a) glass (b) cold air
(c) diamond (d) water

Ans : COMP 2011

The Refractive index of a diamond is 2.42, the refractive index of glass is 1.5, the refractive index of water is 1.33, and the refractive index of cold air is 1.09. All the refractive indexes are smaller than the diamond.
Thus (b) is correct option.

35. A thick glass slab with a silvered side forms multiple images on account of :
(a) refraction of light
(b) both reflection and refraction of light
(c) reflection of light
(d) dispersion of light

Ans : COMP 2021

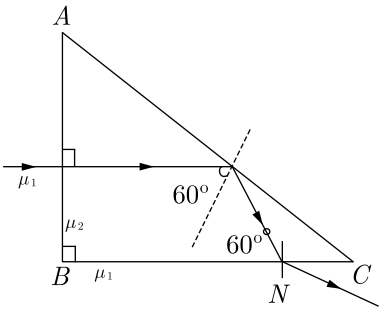
A thick mirror has two surfaces. When the light falls on the upper surface it is divided into two parts, one is reflected and the other is refracted. The refracted part enters the mirror and again is reflected back. Multiple refraction and reflection lead to a number of transmitted and reflected waves with different intensities.
Thus (b) is correct option.

NODIA

Angle of incidence = angle of reflection

So, $i > i_c$ due to which

TIR will occur and the ray gets reflected back in the prism. After that the rays bends away from the normal due to change in medium as shown in the figure.



Thus (b) is correct option.

26. State T for true and F for false

I. To recombine the spectrum to obtain white light, the dispersive prism and recombination prism should be in same position.

II. If a glass prism is dipped in water, its dispersive power decreases.

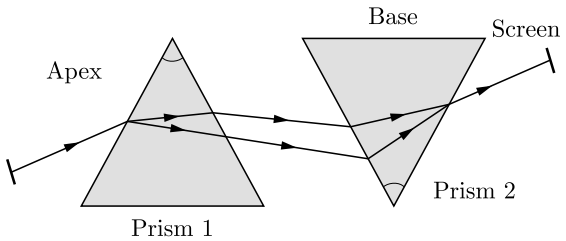
III. When sunlight comes down through the clouds, Tyndall effect is observed.

IV. Headlights are made of yellow colour because of its long wavelength and low scattering.

	I	II	III	IV
(a)	T	T	T	T
(b)	F	T	T	T
(c)	F	F	T	T
(d)	F	T	F	T

Ans : MAIN 2009

To recombine the spectrum to obtain white light, the dispersive prism and recombination prism should be in an inverted position with the dispersion prism.



Statement I is incorrect (false).

Statement II is correct as dispersive power,

$$\omega = \frac{\mu_V - \mu_R}{(\mu - 1)}$$

It depends on (a) angle of prism, (b) nature of material used.

Hence, water's refractive index is more than air, so dispersive power decreases.

Statement III Tyndall effect is scattering, of light when it passes through colloidal solution, where size of the particles is relatively larger.

Sunlight comes down through the clouds, showing Tyndall effect because earth's atmosphere is a heterogeneous, mixture of minute particles of smoke.

Statement IV is also correct as yellow light scatters comparatively less and has comparatively low wavelength, visibility also more. Tiny water droplets, suspended particles of dust and molecules of air which becomes visible during scattering.

Thus (b) is correct option.

27. The focal length of a concave lens is 10 cm. Calculate its power.

(a) $-$ 11.5 D (b) $-$ 10 D

(c) + 11.5 D (d) + 10 D

Ans : SQP 2007

Concave lens has negative focal length.

$$f = -10 \text{ cm}$$

Now, $$P = \frac{100}{f}$$

$$= \frac{100}{-10} = -10 \text{ D}$$

Thus (b) is correct option.

28. A convex lens forms a real image 4 times magnified when placed at a distance of 6 cm from the lens. Calculate the focal length of the lens.

(a) 6.8 cm (b) 8.8 cm

(c) 2.8 cm (d) 4.8 cm

Ans : MAIN 2002

Given, $m = 4, \ u = 6$ cm

$$m = \frac{v}{u}$$

$$u = \frac{v}{6}$$

$$v = 4 \times 6 = 24 \text{ cm}$$

Now $$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\frac{1}{f} = \frac{1}{24} - \left(\frac{1}{-6}\right)$$

$$= \frac{1}{24} + \frac{1}{6} = \frac{1+4}{24}$$

Click Here to Buy book on Amazon

When a ray of light travelling in an optically denser medium, emerges into an optically less denser medium, it deviates away from normal.
Thus (c) is correct option.

76. During spear fishing a fisherman aims at the :
(a) head of fish
(b) slightly ahead of the head of fish
(c) tail of fish
(d) none of these

Ans : MAIN 2021

Due to refraction when the rays travel from water to air the apparent image of the fish is formed at a higher level and ahead of the actual position of fish. Thus when the fisherman aims at the tail of the apparent image of fish his spear hits the head of actual fish.
Thus (c) is correct option.

77. A coin is placed at a depth of 15 cm in a beaker containing water. The refractive index of water is 4/3, calculate height through which the image of the coin is raised.
(a) 3.75 cm (b) 1.75 cm
(c) 2.75 cm (d) 0.75 cm

Ans : SQP 2020

$$\text{Refractive index of water} = \frac{\text{Real depth}}{\text{Apparent depth}}$$

$$\frac{4}{3} = \frac{15\text{ cm}}{x\text{ cm}}$$

$$\text{Apparent depth, } x = \frac{15 \times 3}{4}$$

$$= 11.25\text{ cm}$$

Hence, height through which image is raised

$$= 15 - 11.25$$

$$= 3.75\text{ cm}$$

Thus (a) is correct option.

78. When a ray of light passes through an equilateral glass prism :
(a) it bends towards the base on both refracting surfaces.
(b) it suffers refraction on the first refracting surfaces.
(c) it suffers refraction on both the refracting surfaces.
(d) both (b) and (c)

Ans : MAIN 2023

When a ray of light passes through an equilateral glass prism it suffers refraction on both the refracting surfaces and it bends towards the base on both refracting surfaces
Thus (d) is correct option.

NODIA

79. A concave lens always forms :
(a) real, inverted and enlarged image
(b) virtual, erect and enlarged image
(c) virtual, inverted and enlarged image
(d) virtual, erect and diminished image

Ans : COMP 2000

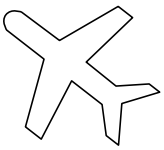
A concave lens always forms a virtual image no matter where the object is. A concave lens is a diverging lens. It causes light to spread out, resulting in a smaller image for the viewer.
Thus (d) is correct option.

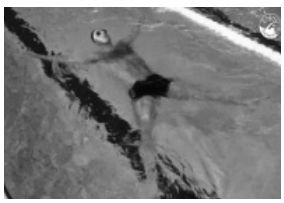
80. Consider the following statements in context with the sign conventions for spherical lens and choose the incorrect one
I. All the distances are measured from the pole of the lens.
II. The distances measured against the direction of incident light are taken as negative.
III. The distances measured downward and perpendicular to the principal axis are taken as negative.
(a) Only II (b) Only I
(c) III only (d) All are incorrect

Ans : SQP 2002

All the distances are measured from the optic centre of the lens according to the sign convention of lens.
Thus (b) is correct option.

81. If a swimmer inside water looks at an aeroplane in the sky, then which of the following conditions are fulfilled ?





(a) For the swimmer, the aeroplane will appear to be lower than it actually is
(b) For the pilot, the swimmer will appear to be at greater depth than it actually is
(c) For the swimmer, the aeroplane will appear to be higher than it actually is
(d) For the swimmer, the aeroplane will appear at its actual height

36. The colour of an opaque object is that colour which it .....
(a) reflects (b) absorbs
(c) refracts (d) deviates

Ans : SQP 2020

The colour of an opaque object is the colour of light that it reflects.
Thus (a) is correct option.

37. Name the machine shown in the figure using gamma radiations in detecting fracture or malignant cells in our body.

(a) MRI machine (b) X ray machine
(c) ECG monitor (d) None of these

Ans : MAIN 2016

Strong magnetic fields are used in creating gamma radiations which can detect the finest of cracks or mal tissues inside our body.
Thus (a) is correct option.

38. Name the waves given out by the two-dish shown in the figure:

(a) Sound waves (b) Light waves
(c) Microwaves (d) Radio waves

Ans : SQP 2021

Long range signals are transmitted as radio waves through towers.
Thus (d) is correct option.

39. UV rays have wavelength ..... that of IR rays.
(a) equal to (b) smaller than
(c) larger than (d) none of these

Ans : COMP 2013

Thus (b) is correct option.

40. The invisible spectrum beyond red of visible spectrum is called ..... spectrum.
(a) Ultraviolet (b) Yellow
(c) Green (d) Infrared

Ans : SQP 2004

In the electromagnetic spectrum, shorter wavelengths (from 10 nm to 380 nm) are ultraviolet (UV) and longer wavelengths (from 750 nm to 1 mm) are infrared (IR) radiation.
Thus (d) is correct option.

41. ..... rays bring about chemical reactions in silver salts.
(a) IR (b) Blue
(c) UV (d) Red

Ans : MAIN 2020

UV rays bring about chemical reactions in silver salts
Thus (c) is correct option.

42. When a wave passes from one medium to another ..... of the wave varies but its ..... remains constant.
(a) velocity, frequency
(b) frequency, velocity
(c) velocity, wavelength
(d) frequency, wavelength

Ans : COMP 2015

Velocity and wavelength changes when a wave moves from one medium to another. But frequency remains constant as it is the characteristics of the source which produces the sound.
Thus (a) is correct option.

43. The unit used to measure wavelength of electromagnetic spectrum is called
(a) hertz
(b) ms^{-1}
(c) meter
(d) Angstrom (A) Unit

Ans : SQP 2011

SI unit of wavelength is Angstrom.
Thus (d) is correct option.

Download NODIA App for All Sample Papers PDFs

Downloaded from www.pdf.tube

44. Name the lens used by an ophthalmologist lens as shown in the figure.

(a) Convex lens
(b) Concave-convex lens
(c) Concave lens
(d) None of the above

Ans : COMP 2000

Enlarged image is obtained only in convex lens
Thus (a) is correct option.

45. The power of a lens produced by it is the measure of ..... .
(a) convergence
(b) divergence
(c) deviation of ray of light
(d) all of the above

Ans : MAIN 2005

The power of a lens is defined by the ability of a lens to converge, in the case of a convex lens, or diverge, in the case of a concave lens, the beam of light falling on it.
Thus (d) is correct option.

46. A concave lens forms the image of an object which is
(a) virtual, upright and diminished
(b) virtual, inverted and enlarged
(c) virtual, inverted and diminished
(d) virtual, upright and enlarged

Ans : COMP 2003

Concave lens forms virtual,upright and diminished image for all positions of the object.
Thus (a) is correct option.

47. A point on the principal axis of a lens such that a ray of light passing through this point emerges parallel to its direction of incidence is called as:
(a) Optical centre
(b) Centre of curvature
(c) Radius of curvature
(d) Focus

Ans : SQP 2011

The rays of light falling on a convex lens in a direction parallel to principal axis of the lens, get refracted through the lens and meet actually at a single point F on the principal axis of the lens. This point is called principal focus of the lens.
Thus (d) is correct option.

48. If the rays from a point object after refraction through the lens do not actually meet at a point, but they appear to diverge from a point the image is .....
(a) imaginary (b) beautiful
(c) virtual (d) real

Ans : SQP 2021

A virtual image is formed when the refracting or reflecting rays do not actually intersect but appear to intersect when they are produced backwards.
Thus (c) is correct option.

NODIA

49. Which lens is thicker at the periphery and thinner in the middle?
(a) Bi-convex (b) plano-convex
(c) convex (d) concave

Ans : COMP 2020

A lens which is thinner at the middle and thicker at the edges is called a concave lens.
Thus (d) is correct option.

50. A ray of light travels undeviating on passing through the optical boundary
(a) both have the same refractive index
(b) the ray makes an angle of 0° with the normal
(c) if both mediums are same
(d) all the above

Ans : MAIN 2013

Thus (d) is correct option.

51. Which lens bulges out in the middle
(a) concave
(b) convex
(c) piano-convex
(d) concavo-convex

Ans : COMP 2019

A convex lens is thicker in the middle and thinner at the edges. It is also known as a converging lens because it converges light rays that pass through it. The shape of a convex lens bulges outward in the center and is thinner towards the edges.
Thus (b) is correct option.

52. Distorted image of a face of a person sitting in front of a camp fire is because of the phenomenon of

(a) diffusion
(b) total internal reflection
(c) refraction
(d) winds blowing

Ans : MAIN 2013

The rays coming from the face of the person, sitting across the campfire, suffer refraction on passing through hot air. Thus, we see the apparent image of the person. Since hot air is in motion, therefore its optical density changes, which in turn shifts the image rapidly. This rapidly shifting image gives a shimmering effect
Thus (c) is correct option.

53. Optical fibre works on the principle of
(a) total internal reflection
(b) optical transmission
(c) satellite signals
(d) internet mobile towers

Ans : SQP 2023

Optical Fiber works on the principle of total internal reflection for its operation.
Thus (a) is correct option.

54. A fish while on the surface of water has its angle of view as α, while it is in water the angle of vision becomes β Compare the two angles of view.
(a) $\alpha = \beta$ (b) $\alpha < \beta$
(c) $\alpha > \beta$ (d) can't say

Ans : COMP 2023

$$\frac{\sin\alpha}{\sin\beta} = \frac{n_2}{n_1} = n > 1$$

$$\sin\alpha > \sin\beta$$

$$\alpha > \beta$$

Thus (c) is correct option.

55. Velocity of light is more in ..... than .....
(a) water, air
(b) sea water, mineral water
(c) air, water
(d) brown glass, transparent glass

Ans : COMP 2010

Optical density of air is less than water.
Thus (c) is correct option.

56. For minimum deviation the angle of incidence ..... angle of refraction.
(a) greater than (b) equal to
(c) less than (d) directly proportional

Ans : MAIN 2011

The angle of minimum deviation is the smallest angle of deviation. The angle of incidence and angle of emergence are equal at the minimal variation. The angle of minimal deviation produced by a prism is determined by the prism's refracting angle and the material's refractive index and the angle of incidence grater than angle of refraction.
Thus (a) is correct option.

57. Lateral displacement ..... with increase in angle of incidence.
(a) remains same (b) keeps changing
(c) increases (d) decreases

Ans : SQP 2008

Lateral displacement increases with increase in angle of incidence and also increases with increase in refractive index.
Thus (c) is correct option.

58. Refraction of light is the phenomenon of
(a) bending of light (b) distribution of light
(c) movement of light (d) scattering of light

Ans : COMP 2005

Refraction is the bending of a wave when it passes from one medium to another. The bending is caused due to the differences in density between the two substances.
Thus (a) is correct option.

59. Lateral displacement is
(a) perpendicular shift between emergent ray and incident ray.
(b) parallel shift between incident ray and emergent ray.
(c) parallel shift between emergent ray and incident ray.
(d) perpendicular shift between incident ray and emergent ray.

Click Here to Buy book on Amazon

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!

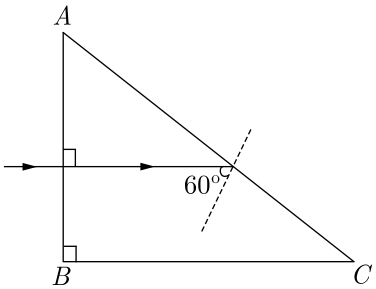
A convex lens act as a prism and a glass slab only when the refracting angle of the prism decreases in an outward direction.
Thus (c) is correct option.

24. How does the light should enter the glass to produce a large amount of bending ?
(a) Obliquely, making a large angle of incidence
(b) Perpendicularly to the glass surface
(c) Obliquely, making a small angle of incidence
(d) All of the above

Ans : SQP 2001

As we know, whenever incident light falls on the interface of glass slab for different values of i , the ratio $\frac{\sin i}{\sin r}$ = constant = refractive index. Thus, refractive index measures the light bending capacity or it measures ability of bending of light when it travels from one transparent medium to another medium.
If the light enters obliquely and angle of incidence is more, then angle of refraction will also increase. Hence, bending is directly proportional to the angle of incidence.
Thus (c) is correct option.

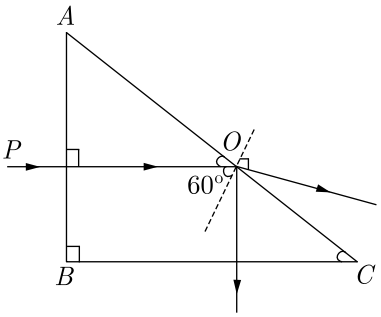
25. The diagram below shows the path of light passing through a right angled prism of critical angle 42°.



(i) The angle C of the prism is
(a) 45° (b) 60°
(c) 90° (d) 30°

Ans : SEM-I 2021

According to the question we can draw the following diagram,



Here, $\angle AOP = \angle C$

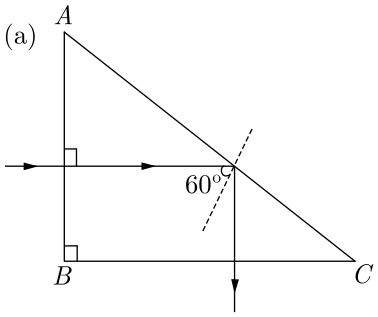
Also, $= 90° - 60° = 30°$

$\angle AOP = \angle C = 30°$

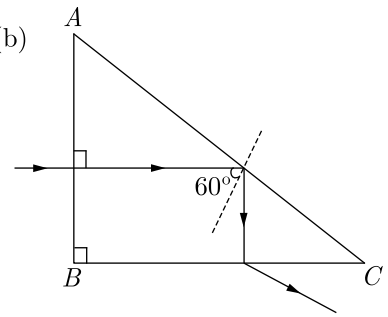
Thus (d) is correct option.

(ii) Which one of the following diagrams show the correct path of this ray till it emerges out of the prism?

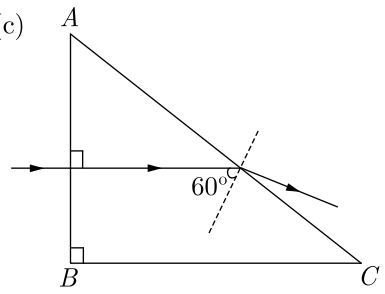
(a)



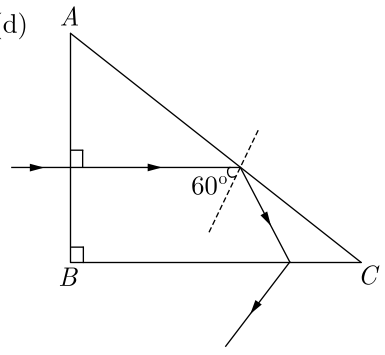
(b)



(c)



(d)



Ans : COMP 2020

critical angle $i_c = 42°$

Here, angle of incidence, $i = 60°$

NODIA

Ans : COMP 2009

An object is placed at a distance of more than 40 cm from a convex lens of focal length 20 cm. The image formed is real, inverted and diminished.
Thus (c) is correct option.

69. State the reason why a paper would burn when placed at a particular distance from a spherical lens.

(a) due to converging power of lens
(b) paper is placed at the focal plane of lens
(c) due to refraction
(d) all of the above

Ans : MAIN 2011

Parallel beam of light when incident on a converging lens would converge at the focus thus increasing the intensity of light incident thus burn the Paper.
Thus (d) is correct option.

70. The angle through which a light of a particular wavelength can deviate, while passing through prism is called ..... .
(a) Refrangibility
(b) Angle of emergence
(c) Angle of refraction
(d) Angle of reflection

Ans : COMP 2004

The angle through which a light of a particular wavelength can deviate, while passing through prism is called angle of refraction.
Thus (c) is correct option.

71. The phenomenon due of which a polychromatic light split into its component colours, when passed through a prism is called .....
(a) Refraction (b) Interference
(c) Reflection (d) Dispersion

Ans : MAIN 2008

The phenomenon due of which a polychromatic light split into its component colours, when passed through a prism is called dispersion
Thus (d) is correct option.

72. A transparent object ..... its own colour to pass through and ..... all other colours.
(a) allows, absorbs (b) allows, refracts
(c) absorbs, allows (d) allows, reflects

Ans : SQP 2002

A transparent object allow its own colour to pass through and absorbs all other colours.
Thus (a) is correct option.

73. ..... rays are used in detecting fake currency and diamonds.
(a) Blue (b) Infrared
(c) Green (d) Ultra violet

Ans : MAIN 2009

In fake notes and documents, the ink which is used gives fluorescence effects after it is bombarded with UV rays. From this bank officers can find out which part of currency is glowing and which is not. This makes it easy to find out the fake currency as the fake currency does not show proper fluorescence where it is required.
Thus (d) is correct option.

74. Name the radiations used while taking the following photograph:

(a) Infrared (b) Ultra violet
(c) Radio (d) Yellow

Ans : COMP 2008

Reddish nature of photographs is due to infrared radiations used in photography.
Thus (a) is correct option.

75. When a ray of light travelling in an optically denser medium, emerges into an optically less denser medium it -
(a) deviates towards the normal
(b) gets reflected
(c) deviates away from normal
(d) does not deviate

Ans : SQP 2005

NODIA

Ans : SQP 2011

A ray of light travels in a certain straight line path. After refraction through a glass slab, it emerges in a direction parallel to the original direction but slightly displaced from the line. This is called the lateral displacement.
Thus (d) is correct option.

60. A coconut tree appears to be ..... when viewed by a sea diver from below the water surface.
(a) same size (b) distorted
(c) taller (d) shorter

Ans : COMP 2003

A coconut tree appears to be taller when viewed by a sea diver from below the water surface.
Thus (c) is correct option.

61. The refracted ray is ..... to the base of the prism in minimum deviation position.
(a) collinear (b) parallel
(c) perpendicular (d) inclined

Ans : SQP 2021

When the refracted ray in the prism is parallel to its base deviation is minimum. When the angle of incidence is equal to the angle of the emergence then the angle of deviation is minimum.
Thus (b) is correct option.

62. Why does this stone sparkle?

(a) light being entrapped inside it due to low critical angle.
(b) bending of light.
(c) refraction of light.
(d) reflection of light.

Ans : MAIN 2020

Diamond has a very high refractive index. It is because of this property that diamond sparkles. When light enters the diamond crystal, it suffers multiple total internal reflections and due to this, it sparkles.
Thus (a) is correct option.

63. The plano-convex lens has
(a) Both surfaces convex
(b) Both concave
(c) One plane, one convex
(d) One convex, one concave

Ans : SQP 2022

Plano-convex lenses are positive focal length elements that have one spherical surface and one flat surface.
Thus (c) is correct option.

64. A plano-lenses has one surface ..... and the other surface plane.
(a) rectangular (b) triangular
(c) oval (d) spherical

Ans : COMP 2002

A plano-lenses has one surface spherical and the other surface plane.
Thus (d) is correct option.

65. Which lens has both the surfaces as concave?
(a) plano-convex (b) plano-concave
(c) bi-convex (d) bi-concave

Ans : MAIN 2009

A lens having two spherical surfaces both curved inside is called a concave lens.
Thus (d) is correct option.

66. Convex lens produces a ..... image.
(a) real (b) virtual
(c) both (a) and (b) (d) none of these

Ans : SQP 2002

Concave lens always produces virtual image and convex lens always produces real image.
Thus (c) is correct option.

67. A lens forms an upright and diminished image of an object irrespective of its position. Name the lens.
(a) double concave (b) double convex
(c) planoconcave (d) piano-convex

Ans : SQP 2006

Thus (a) is correct option.

68. An object is placed at a distance of more than 40 cm from a convex lens of focal length 20 cm. The image formed is real, inverted and
(a) same as (or equal to)
(b) magnified
(c) diminished
(d) none of the above

Downloaded from www.pdf.tube

Ans : SQP 2006

As the swimmer is inside the water doing backstroke swimming, so the object is in denser medium. Water is a denser medium, so when light travels from water to air i.e., denser to rarer, it will bend away from the normal, as a result of which aeroplane will appear to be higher than its actual position.
Thus (c) is correct option.

82. The angle of deviation is maximum for ..... when the dispersion of polychromatic light takes place
(a) green (b) blue
(c) violet (d) red

Ans : MAIN 2020

The angle of deviation is maximum for violet when the dispersion of polychromatic light takes place.
Thus (c) is correct option.

83. X-rays are produced by
(a) oscillating circuits in special vacuum tubes
(b) nucleus of an atom, by the destruction of high energy particle
(c) excitation of outermost electronic shell of an atom
(d) excitation of inner electron of atom and is sudden annihilation of high energy free electrons

Ans : MAIN 2002

X-rays are commonly produced in X-ray tubes by accelerating electrons through a potential difference (a voltage drop) and directing them onto a target material (i.e. tungsten).
Thus (d) is correct option.

84. Name the phenomenon occurring in the following figure:

(a) reflection (b) distortion
(c) refraction (d) none of these

Ans : MAIN 2015

Ray of light travelling from denser to rarer medium. So, refraction is occurs at the interface surface.
Thus (c) is correct option.

85. Slimmer the glass slab ..... the lateral displacement.
(a) more (b) equal
(c) less (d) none of these

Ans : COMP 2020

Slimmer the glass slab less the lateral displacement.
Thus (c) is correct option.

86. Diamond sparkle because of ..... .
(a) Refraction followed by T.I.R
(b) T.I.R followed by refraction
(c) T.I.R followed by entrapping of light inside it
(d) none of the above

Ans : MAIN 2006

Large cut surfaces and low critical angle entraps the light inside giving it sparkling effect
Thus (c) is correct option.

87. A ray of light from the light house reaches the submarine which is under water. The sailor places a plane mirror such that angle between the light ray and the mirror is 0°. Where would he see the light house?
(a) he won't see the light source at all
(b) at the same position as no refraction occurs
(c) it is pitch dark to relocate the light from the submarine.
(d) at the same position as light reverses along the same path

Ans : SQP 2019

Refraction of light from denser medium to rare medium.
Thus (d) is correct option.

88. Concave lens is also known as
(a) diverging lens (b) dual lens
(c) converging lens (d) none of the above

Ans : COMP 2013

Concave lenses are thinner at the middle. Rays of light that pass through the lens are spread out (they diverge). A concave lens is a diverging lens.
Thus (a) is correct option.

NODIA

Ans : SQP 2005

Velocity of light is inversely proportional to the refractive index.
Thus (a) is correct option.

102. A lightning strikes a window pane and produces a crack in it. This crack appears silvery because of ..... .
(a) Total internal reflection
(b) Diffraction
(c) Fineness of the crack
(d) Light being entrapped in the crack

Ans : COMP 2011

Light trying to travel from glass to air at an angle greater than critical angle.
Thus (a) is correct option.

103. The refractive index of glass is 1.5 when the ray of light travels from air to glass. Calculate the refractive index when light travels from glass to air.
(a) 0.5 (b) 1.5
(c) 0.67 (d) 0.33

Ans : MAIN 2002

Refractive index of glass w.r.t air is reciprocal of refractive index of air w.r.t glass
The refractive index when light travels from glass to air is given by

$$= \frac{1}{1.5} = 0.67$$

Thus (c) is correct option.

104. A ray incident on the lens from the object, gets ..... through the lens obeying the laws of refraction.
(a) absorbed (b) reflected
(c) refracted (d) none of these

Ans : SQP 2003

A ray incident on the lens from the object, gets refracted through the lens obeying the laws of refraction.
Thus (c) is correct option.

105. A lens which forms a real image has a focal length of 8cm. Find its power.
(a) +2.5D (b) –2.5D
(c) –12.5D (d) +12.5D

Ans : MAIN 2006

$$\text{Power of lens} = 100 \,/\, \text{focal length}$$
$$= \frac{100}{8} = 12.5\text{D}$$

Thus (d) is correct option.

106. A skeletal analysis of skull is shown in the figure below. Name the rays used to obtain the same?

(a) Microwaves (b) X rays
(c) Sun rays (d) Infra-red

Ans : MAIN 2008

X rays have high penetrating power so can detect any cracks in joints or skull.
Thus (b) is correct option.

107. Rock salt prism does not absorb ..... radiation.
(a) UV (b) IR
(c) microwave (d) radio-wave

Ans : COMP 2000

Infrared spectrum can be obtained only with the help of a rock-salt prism since the rock salt prism does not absorb infrared radiations where as a glass prism absorbs them.
Thus (b) is correct option.

108. During sun rise or sun set, the sun appears bigger because the rays of light coming from it pass through
(a) smaller length of atmosphere
(b) larger length of atmosphere
(c) the earth gets closer to sun
(d) none of these

Ans : SQP 2008

During sunset or sunrise, the rays of light from the sun travel through a long distance through air. Thus, the apparent image of the sun is formed closer to the eye, which in turn appears bigger.
Thus (b) is correct option.

FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

Click Here to Buy book on Amazon

sine of the angle of incidence and the sine of the angle of refraction.
As the refractive index of the two mediums '
a and b are equal, the angles are also equal and they can be treated as one medium, so the ray of light will suffer reflection at the interfaces partly.
Thus (a) is correct option.

97. Small air bubbles rising up a fish tank appear silvery when viewed from some particular angle because of the phenomenon of :
(a) reflection
(b) dispersion
(c) refraction
(d) total internal reflection

Ans : SQP 2003

Small air bubbles rising up a fish tank appear silvery when viewed from some particular angle because of the phenomenon of total internal reflection.
Thus (d) is correct option.

98. An object when placed in front of a convex lens forms a real image of 0.5 magnification. If the distance of the image from the lens is 24 cm, calculate focal length of the lens.
(a) 2 cm (b) 4 cm
(c) 8 cm (d) 6 cm

Ans : COMP 2015

Given, $m = 0.5$

$v = 24$ cm

$m = \frac{v}{u} = \frac{24}{u}$

$0.5 = \frac{1}{2} = \frac{24}{u}$

$u = 48$ cm

Now, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$f = \frac{1}{24} - \frac{1}{48} = \frac{2-1}{48} = \frac{1}{48}$

$f = 48$ cm

If in the question 24 cm is distance of object from lens, then

$m = \frac{v}{u}$

$\frac{1}{2} = \frac{v}{24}$

$v = \frac{24}{2} = 12$ cm

Again, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

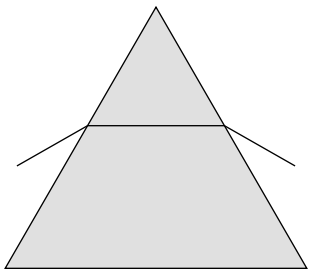
$\frac{1}{f} = \frac{1}{12} - \left(\frac{1}{-24}\right)$

$\frac{1}{f} = \frac{1}{12} + \frac{1}{24} = \frac{2+1}{24} = \frac{3}{24}$

$f = \frac{24}{3} = 8$ cm

Thus (c) is correct option.

99. If a ray of light enters glass prism (as shown in figure) of refractive index 1.5, then the speed of light inside the prism will be



(a) 0.2×10^8 ms^{-1} (b) 2×10^9 ms^{-1}
(c) 2×10^8 ms^{-1} (d) 2×10^7 ms^{-1}

Ans : COMP 2020

According to the Snell's law,
Refractive index,

$$\mu = \frac{\text{Speed of light in air}}{\text{Speed of light in medium}}$$

$$1.5 = \frac{3 \times 10^8}{v}$$

$$v = \frac{3 \times 10^8}{1.5} = 2 \times 10^8 \text{ m/s}$$

Thus (c) is correct option.

100. A ray of light bends ..... the normal when it travels from optically rarer medium to an optically denser medium
(a) far away (b) very close
(c) away (d) towards

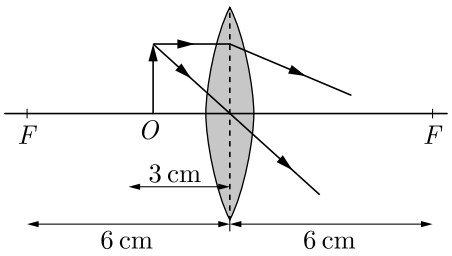
Ans : MAIN 2003

Due to refraction of light, when a ray of light passes from a rarer medium to a denser medium, bends towards the normal to the boundary between the two media. The amount of bending depends on the indices of refraction of the two media.
Thus (d) is correct option.

101. Velocity of light is ..... to refractive index.
(a) inversely proportional
(b) independent
(c) directly proportional
(d) none of the above

NODIA

138. The diagram shows an object O placed 3 cm away from a converging lens of focal length 6 cm.

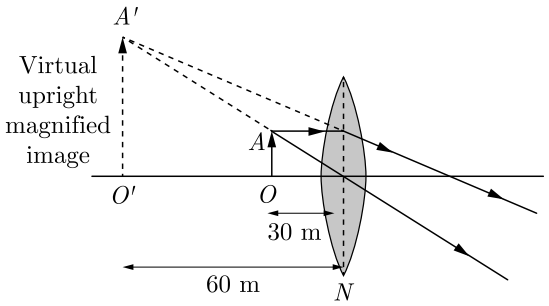


What type of image is produced ?
(a) Real, upright and diminished
(b) Virtual, inverted and diminished
(c) Real, inverted and magnified
(d) Virtual, upright and magnified

Ans : COMP 2016

Focal length of the lens = 6 cm

As, the object is between optic centre and focus, the image formed will be virtual, erect (upright) and magnified.



Thus (d) is correct option.

139. Violet has the smallest wavelength, but colour of sky is blue. Why ?
(a) Our eyes are less sensitive to violet colour.
(b) Most of the violet rays are absorbed by the atmosphere.
(c) Both (a) and (b)
(d) Neither (a) nor (b)

Ans : SQP 2011

Though violet has the smallest wavelength, but colour of sky is blue because our eyes are more sensitive to blue colour less sensitive to violet colour and most of the violet rays are absorbed by the atmosphere.
Thus (c) is correct option.

140. A lens which forms a real image has a focal length 8 cm. Calculate its power.
(a) + 12.5 D (b) + 11.5 D
(c) − 12.5 D (d) − 11.5 D

Ans : MAIN 2016

$$\text{Focal length} = 8 \text{ cm} = \frac{8}{100} \text{ m}$$

$$\text{Power } P = \frac{1}{f(\text{in metres})}$$

$$= \frac{100}{8} = 12.5\text{D}$$

Thus (a) is correct option.

141. For total internal reflection to take place a ray of light must:
(a) travel from rarer to denser medium
(b) medium does not play any role
(c) travel from denser to rarer medium
(d) none of these

Ans : COMP 2007

The two conditions for the total internal reflection to take place are as follows:
1. Throughout the denser medium, the angle of incidence must've been larger than the critical angle for this kind of combination of media.
2. A light ray might move from a denser medium toward a rarer medium.

Thus (c) is correct option.

142. Lateral displacement occurs in case of
(a) rectangular glass block
(b) two equiangular prisms held near each other with faces parallel to one another
(c) Cuboid glass block
(d) all of the above

Ans : SQP 2021

As lateral surfaces are parallel to each other
Thus (d) is correct option.

143. Water being completely transparent can appear shiny like a mirror due to
(a) refraction of light
(b) absorption of light.
(c) Total internal reflection
(d) dispersion

Ans : COMP 2015

Angle of incidence greater than critical angle.
Thus (c) is correct option.

144. A light, which is a mixture of several colours is called ..... light.
(a) Polychromatic
(b) Monochromatic
(c) Singular
(d) Ultraviolet

Ans : SQP 2000

Downloaded from www.pdf.tube

109. Diamonds sparkle more than the glass, because they have
(a) larger critical angle than the glass
(b) critical angle plays no role
(c) smaller critical angle than the glass
(d) none of these

Ans : COMP 2014

Diamonds are designed in such a way that their angles are very sharp which leads to a number of refractive surfaces. The critical angle of a diamond is less because of which when a ray enters, it suffers a series of total internal reflections. The rays get trapped in it making it sparkle.
Thus (b) is correct option.

110. What type of lens is used in the case below?

(a) reflecting lens (b) translucent lens
(c) converging lens (d) diverging lens

Ans : SQP 2005

A convex lens is used in the door hole to see larger size of the image.
Thus (c) is correct option.

111. The velocity of light in air is 3×10^8 ms^{-1} and in glass is 2×10^8 ms^{-1}. Find the refractive index of glass.
(a) 1.5 (b) 0.5
(c) 2.5 (d) 3.5

Ans : MAIN 2019

$$\text{R.I. of glass } {}_a\mu_g = \frac{\text{velocity of light in air}}{\text{velocity of light in glass}}$$

$${}_a\mu_g = \frac{3 \times 10^8}{2 \times 10^8} = 1.5$$

Thus (a) is correct option.

112. The floor of a water tank appears at a depth of 2.5 m. If the refractive index of water is 1.33, find the actual depth of water.
(a) 1.325 m (b) 3.325 m
(c) 2.325 m (d) 4.325 m

Ans : MAIN 2003

$$\text{Observed depth} = 2.5 \text{ m}$$

$$\text{Refractive index of water} = 1.33$$

$$\text{Refractive index} = \frac{\text{Real depth}}{\text{Apparent depth}}$$

$$1.33 = \frac{x}{2.5}$$

$$\text{Actual depth } x = 1.33 \times 2.5$$

$$= 3.325$$

$$= 3.325 \text{ m}$$

Thus (b) is correct option.

113. A lens forms an inverted image of an object equal to its own size. The object is :
(a) beyond infinity and $2F_1$
(b) in between F_1 and optical centre
(c) at $2F_1$
(d) between $2F_1$ and F_1

Ans : MAIN 2005

When object is situated at $2F_1$ than lens forms an inverted image of an object equal to its own size.
Thus (c) is correct option.

114. Absolute refractive index of some materials A, B, C and D are given as below :

Medium	A	B	C	D
Refractive index	1.54	1.33	2.42	1.65

(a) A (b) D
(c) C (d) B

Ans : COMP 2022

As medium B has least refractive index i.e., 1.33, hence light travels fastest in medium B because least refractive index indicates that B is much optically rarer than all other medium, hence light travels fastest in medium B.
Thus (d) is correct option.

115. A convex lens of focal length 40 cm, a concave lens of focal length 40 cm and a concave lens of focal length 15 cm are placed in contact. The power of the combination in dioptre is
(a) − 6.67 (b) − 1.5
(c) + 6.67 (d) + 1.5

Ans : COMP 2013

Given, $f_1 = 40$ cm

$f_2 = -40$ cm

$f_3 = -15$ cm

According to the question, total focal lengths of

the combination is given by

$$f = f_1 - f_2 - f_3$$
$$= 40 - 40 - 15$$
$$-15 \text{ cm}$$

Power of the combination,

$$P = \frac{1}{f}$$
$$= -\frac{1}{15} = -\frac{100}{15}$$
$$= -6.67 \text{ D}$$

Thus (a) is correct option.

116. It is said that stars twinkle but sun also being a star doesn't twinkle as is seen. Why is it that sun doesn't twinkle?

(a) Sun is made of fire
(b) Sun is the nearest star
(c) Sun is made of plasma
(d) Sun is formed by the fusion reaction of hydrogen isotopes

Ans : SQP 2006

Thus (b) is correct option.

117. Where should an object be placed in front of a convex lens so as to form an upright and enlarged image?
(a) at 2F
(b) between F and 2F
(c) at focus
(d) between optical centre and focus

Ans : COMP 2011

Object be placed between optical centre and focus in front of a convex lens so as to form an upright and enlarged image.
Thus (d) is correct option.

118. State the correct condition when the lens has both its focal lengths equal.
(a) medium is same on either side of lens
(b) when refractive index is one
(c) medium is different on either side of lens
(d) All of the above

Ans : COMP 2004

Refractive index of both media are same.
Thus (a) is correct option.

119. Where is the object placed in the device shown in the diagram to obtain a highly enlarged size of image?

(a) object placed between F and 2F
(b) object is between O and F
(c) object is placed beyond 2F
(d) object is placed at F

Ans : SQP 2022

Since the lens used is a convex lens a highly magnified image is obtained when the object is placed between optical centre and the focus which is an erect image.
Thus (b) is correct option.

120. The electromagnetic wave associated with high energy is :
(a) gamma ray (b) infrared ray
(c) ultraviolet ray (d) X-ray

Ans : MAIN 2009

Gamma rays have the smallest wavelengths and the most energy of any wave in the electromagnetic spectrum
Thus (a) is correct option.

Click Here to Buy book on Amazon

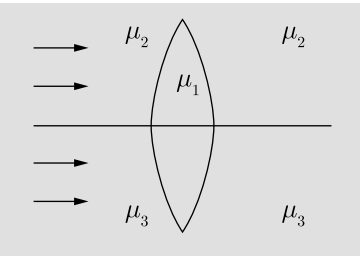
121. When a ray of light enters into another optical medium, its wavelength and velocity change. The material in which wavelength and velocity decrease maximum, when the ray is travelling through air is :

(a) glass (b) water
(c) alcohol (d) diamond

Ans : SQP 2021

When a ray of light enters another optical medium, its wavelength and velocity change. The material in which wavelength and velocity decrease maximum, when the ray is traveling through air is diamond. Because when the light travels from a rarer medium to the denser medium the speed of light is decreased.
Thus (d) is correct option.

122. A double convex lens, made of a material of refractive index μ_1, is placed inside two liquids of refractive indices μ_2 and μ_3 as shown $\mu_2 > \mu_1 > \mu_3$. A wide, parallel beam of light is incident on the lens from the left. The lens will give rise to



(a) A single convergent beam
(b) A convergent and a divergent beam
(c) Two different convergent beams
(d) Two different divergent beams

Ans : MAIN 2023

As $\mu_2 > \mu_1$, hence in the interface of material of refractive index μ_1 and convex lens i.e., from denser to rarer medium parallel ray will bend away from normal and for $\mu_1 > \mu_3$ i.e., interface of material of refractive index μ_1 and μ_3, ray will become convergent, towards the normal, hence a convergent and a divergent beam is produced.
Thus (b) is correct option.

123. Two lenses of power − 3.5 D and + 1.0 D one placed in contact with each other. What is the focal length of this combination ?

(a) 30 cm (b) 40 cm
(c) 10 cm (d) 20 cm

Ans : COMP 2014

Given, $P_1 = -3.5$ D,

$P_2 = +1.0$ D

As, both the lenses are in contact, combination of lenses will have power

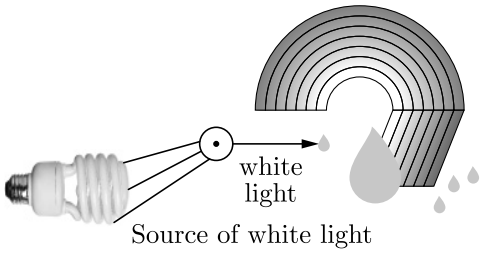
$$= P_1 + P_2 = -3.5 + 1.0$$
$$= -2.5 \text{ D}$$

Focal length, $f = \frac{1}{P_{\text{comb}}}$

$$= +\frac{1}{2.5}\text{D}$$
$$= +\frac{1000}{2.5} = +40 \text{ cm}$$

Thus (b) is correct option.

124. In a science project, a student tried to show rainbow formation using artificial rain and strong source of white light as shown in figure below. What should be the position of observer to observe the rainbow ?



(a) Looking towards the source
(b) Looking towards the raindrop such that he is equally inclined towards the source of raindrops
(c) Looking towards the raindrops with the source behind him
(d) Looking anywhere in the room

Ans : SQP 2020

One of the condition for formation of rainbow is to looking at the sky through water with sun (source) behind observer, total internal reflection can take place in rainbow formation.
Thus (c) is correct option.

125. Thicker the glass slab ..... is the object appearing to be raised

(b) less (b) more
(c) uniform (d) all of these

Ans : MAIN 2016

When a thick glass slab is placed over some printed matter prints seem to be raised due to the refraction of light.
Thus (b) is correct option.

Downloaded from www.pdf.tube

126. The distance from the optical centre O of the lens to its ..... is called the first focal length, of the lens.
(a) 2nd focal point (b) First focal point
(c) 2nd local point (d) None of these

Ans : COMP 2015

The distance between the optical centre and principal focus is called focal length of the lens. Principal focus is the point where parallel rays coming from infinity meet or appear to meet.
Thus (b) is correct option.

127. A band of colour obtained on the screen when polychromatic light splits into colour is called .....
(a) Spectrum (b) Diffraction
(c) Interference (d) Bright band

Ans : SQP 2013

Dispersion is the phenomenon of splitting of polychromatic light into its constituent colours. The band of colours obtained on the screen on passing white light through a prism is called a spectrum.
Thus (a) is correct option.

128. A watery image is seen on the road during hot summer days as seen in the figure. What is this occurrence called?

(a) Mirage (b) looming
(c) reflection (d) inverted image

Ans : SQP 2020

The mirage is caused by the total internal reflection of light at layers of air of different densities. In a desert, the sand is very hot during day time and a result the layer of air in contact with it gets heated up and becomes lighter. The lighter air rises up and the denser air from above comes down.
Thus (a) is correct option.

129. A convex lens produces the image of the same size as the object when placed at a distance of 30 cm. Hence its focal length is?
(a) 15 cm (b) 20 cm
(c) 25 cm (d) 30 cm

Ans : COMP 2011

Same size of image is formed when object is at 2F.
Thus (a) is correct option.

130. ..... waves are used for analysis of atomic and molecular structure.
(a) Micro (b) Radio
(c) IR (d) UV

Ans : MAIN 2005

Microwaves are used for analysis of atomic and molecular structure.
Thus (a) is correct option.

131. The velocity of light in air is 3×10^8 ms^{-1}. Calculate the velocity of light in diamond or refractive index 2.5.
(a) 1.2×10^8 ms^{-1} (b) 0.2×10^8 ms^{-1}
(c) 2.2×10^8 ms^{-1} (d) 3.2×10^8 ms^{-1}

Ans : COMP 2007

$$\text{Velocity of light in air} = 3 \times 10^8 \text{ ms}^{-1}$$

$$\text{Velocity of light in diamond} = ?$$

$$\text{Refractive index of diamond} = 2.5$$

$$_a\mu_d = \frac{\text{velocity of light in air}}{\text{velocity of light in diamond}}$$

$$2.5 = \frac{3 \times 10^8}{\text{velocity of light in diamond}}$$

Hence, velocity of light in diamond

$$= \frac{3}{2.5} \times 10^8$$

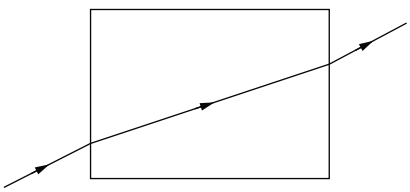
$$v_d = \frac{30}{25} \times 10^8$$

$$= 1.2 \times 10^8 \text{ ms}^{-1}$$

Thus (a) is correct option.

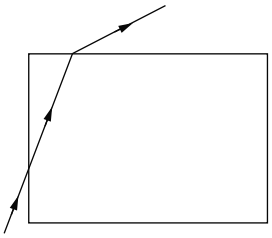
132. A ray of light is incident on one side of a rectangular glass block. Its path is plotted through the block and out through another side. Which path is not possible ?

(a)

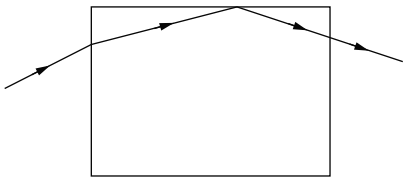


NODIA

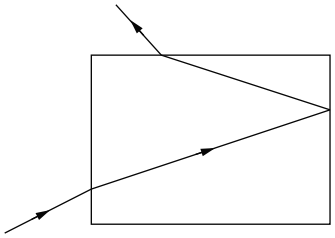
(b)



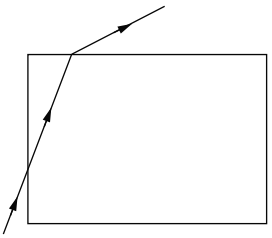
(c)



(d)



Ans : SQP 2021



As glass is an optically denser medium, it bends the light rays towards the normal. After refraction, when light emerge out of the denser medium like glass to the rarer medium like air, it bends away from the normal which is not shown in figure (b). Hence, it is not following rules of refraction.
Thus (b) is correct option.

133. A lens forms an inverted image of an object what kind of lens is this?
(a) concavo-convex (b) convexo-concave
(c) concave (d) convex

Ans : MAIN 2019

A convex lens forms an inverted image of an object.
Thus (d) is correct option.

134. A black object ..... while a white object ..... all colours of light.
(a) absorbs, refracts (b) absorbs, reflects
(c) reflects, absorbs (d) refracts, absorbs

Ans : COMP 2002

A black object absorbs all wavelengths of light and reflects none and that's why it appears black. Consequently, black absorbs the most heat. Objects that are white, on the other hand, reflect all wavelengths of light and that's why they appear white to us, therefore absorb the least heat.
Thus (b) is correct option.

135. A spectrum in which various bands of colour have no sharp, well defined boundaries, but merge in each other is called ..... .
(a) Infrared spectrum (b) Impure spectrum
(c) Red spectrum (d) Pure spectrum

Ans : SQP 2007

A spectrum in which various bands of colours have no sharp well defined boundaries, but merge in each other is called impure spectrum.
Thus (b) is correct option.

136. A prism has :
(a) three rectangular and three triangular surfaces
(b) two rectangular and three triangular surfaces
(c) two triangular and three rectangular surfaces
(d) none of these

Ans : SQP 2001

A Triangular prism has two triangular faces and three rectangular faces as shown in the image below.
Thus (c) is correct option.

137. The point on the principal axis of a convex lens, such that rays of light starting from it on passing through the lens, move parallel to the principal axis is called :
(a) optical centre (b) aperture of lens
(c) first focal point (d) second focal point

Ans : MAIN 2006

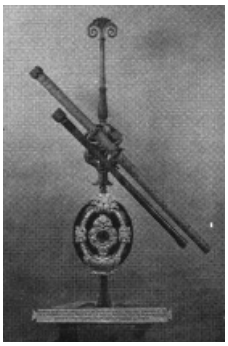
First focal point is the point where the rays starting from it when passes through the lens go parallel to the axis.
Thus (c) is correct option.

DOWNLOAD INDIA'S BEST STUDY MOBILE APP
- 20 Sample Paper with Solutions
- Chapterwise Question Bank of All Subject
- Previous 15 Years Solved Papers
- Case Study Questions with full Solutions

Search by NODIA on Play Store to Download App

Click Here to Buy book on Amazon

89. Which was the lens used in the original Galilean telescope?



(a) both convex
(b) one convex and one concave
(c) both concave
(d) none of the above

Ans : SQP 2008

A Galilean telescope is defined as having one convex lens and one concave lens. The concave lens serves as the eyepiece, while the convex lens serves as the objective.
Thus (b) is correct option.

90. If a part of the lens is covered, its focal length .....
(a) decreases (b) remains unchanged
(c) increases (d) none of the above

Ans : SQP 2019

Thus (a) is correct option.

91. Which lens has one surface plane and another surface convex?
(a) bi-convex (b) bi-concave
(c) plano-convex (d) piano-concave

Ans :

A plano-concave lens has one surface plane and the other surface convex.
Thus (c) is correct option.

92. In following case, where must an object be placed in front of a convex lens so that the image formed is at infinity.
(a) at 2F (b) between F and 2F
(c) at Focus (d) None of these

Ans : COMP 2007

In order to form the image at infinity, the object should be placed at focus, in front of a convex lens.
Thus (c) is correct option.

93. A light which consists of one colour or one wavelength only is called .....
(a) Polychromatic (b) Ultraviolet
(c) Monochromatic (d) Infrared

Ans : COMP 2011

A light which is composed of a single colour is called monochromatic light. It consists of single wavelength.
Thus (c) is correct option.

94. The device used in the figure uses ..... radiations to cook food.

(a) safe vault (b) mini oven
(c) microwave oven (d) none of these

Ans : MAIN 2008

A microwave oven is an electric oven that heats and cooks food by exposing it to electromagnetic radiation in the microwave frequency range. This induces polar molecules in the food to rotate and produce thermal energy in a process known as dielectric heating.
Thus (c) is correct option.

95. Gamma rays have frequency ..... that of *X*-rays.
(a) equal to (b) smaller than
(c) larger than (d) none of these

Ans : COMP 2000

Gamma rays have frequency large than that of *X*-rays. Because the wavelength of gamma rays is less than X rays.
Thus (c) is correct option.

96. Two medium 'a' and 'b' have same refractive index. A ray of light travelling from medium 'a' to medium 'b' will suffer?
(a) partly suffer reflection at the interfaces
(b) partly gets absorbed in medium 'b'
(c) refraction at the interfaces.
(d) Both (b) and (c)

Ans : MAIN 2002

The refractive index of the material in which the angle refraction is located is the ratio between the

NODIA

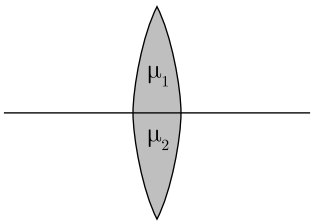
White light consists of different colors of light with different wavelength. Thus it is a polychromatic light.
Thus (a) is correct option.

145. A crack in the window pane appears silvery when viewed from some particular angle. This phenomenon due to :
(a) refraction of light
(b) reflection of light
(c) dispersion of light
(d) total internal reflection of light

Ans : MAIN 2013

A crack in a glass windowpane appears silvery because of the presence of air in the crack, which results in total internal reflection.
Thus (d) is correct option.

146. Which of the following is true for rays coming from infinity ?



(a) Continuous image is formed between focal points of upper and lower lens.
(b) One image is formed.
(c) Two images are formed.
(d) None of the above.

Ans : MAIN 2011

For rays coming from infinity to a lens having different refractive indices μ_1 and μ_2 will form two images at two different foci.
Thus (c) is correct option.

147. During the Sunset the colour which scatters closest to the eye of observer is :
(a) yellow (b) blue
(c) red (d) violet

Ans : SQP 2016

Red color has a longer wavelength, its intensity reach to the observer is more compared to other colors. Hence the sun appears red during sunrise and sunset.
Thus (c) is correct option.

148. ..... radiations are not absorbed by quartz prism.
(a) Micro (b) Radio
(c) UV (d) IR

Ans : COMP 2015

UV radiations are not absorbed by quartz prism
Thus (c) is correct option.

149. If the intensity of light entering the lens decreases the intensity of image formed by it .....
(a) remains same (b) increases
(c) decreases (d) both (a) and (c)

Ans : SQP 2011

Thus (c) is correct option.

150. A fisherman points towards the ..... while harpoon hunting.
(a) head (b) body
(c) tail (d) eye

Ans : MAIN 2015

Due to refraction when the rays travel from water to air the apparent image of the fish is formed at a higher level and ahead of the actual position of fish. Thus when the fisherman aims at the tail of the apparent image of fish his spear hits the head of actual fish. l
Thus (c) is correct option.

151. ..... waves are mainly used in radar.
(a) X-rays (b) IR
(c) Radio (d) UV

Ans : COMP 2021

Radio waves are mainly used in radar.
Thus (c) is correct option.

152. The regions of spectrum which do not excite the retina and hence are not visible, are collectively called ..... spectrum.
(a) Impure (b) Pure
(c) Invisible (d) Sensitive

Ans : SQP 2019

The part of spectrum beyond the red and the violet ends is called the invisible spectrum as our eyes do not respond to the spectrum beyond the red and the violet extremes.
Thus (c) is correct option.

153. The electromagnetic radiation which are useful in night photography is :
(a) ultraviolet rays (b) infrared rays
(c) visible light (d) X-rays

Ans : COMP 2019

Downloaded from www.pdf.tube

203. Name any four regions of electromagnetic spectrum (other than visible light) in increasing order of wavelength.

Ans : MAIN 2011

Four regions of electromagnetic spectrum in increasing order of wavelength are gamma rays, X-rays, ultraviolet rays, infrared rays.

204. State three characteristics of the image formed by a concave lens.

Ans : MAIN 2019

(i) Virtual image
(ii) Upright or erect and
(iii) Diminished.

205. What happens to the image formed by a convex lens if its lower part is blackened ?

Ans : SQP 2012

Every part of a lens forms a complete image. If the lower part of the lens is blackened the complete image will be formed but its intensity will decrease.

206. Can we obtain a real image with the help of a concave lens ?

Ans : COMP 2003

Yes, when a concave lens is placed in the path of a converging beam, it produces a real image.

207. What is meant by 'dispersion of light'?

Ans : SQP 2013

Dispersion is the splitting of white light into its constituent colours.

208. In the atmosphere which colour of light gets scattered the least?

Ans : SQP 2013

In the atmosphere red light gets least scattered.

209. When does a ray of light falling on a lens pass through it undeviating?

Ans :

When a ray of light falling on a lens passes through the optical centre of the lens, it passes undeviating.

210. Which lens can produce a real and inverted image of an object?

Ans : COMP 2002

A convex lens (or converging lens) can produce a real and inverted image of an object.

211. How is the refractive index of a medium related to its real depth and apparent depth?

Ans :

$$\text{Refractive index of a medium} = \frac{\text{Real depth}}{\text{Apparent depth}}$$

212. Which characteristic property of light is responsible for the blue colour of the sky?

Ans : COMP 2011

Scattering of light is the characteristic property of light which is responsible for the blue colour of the sky.

213. Why is white light considered to be polychromatic in nature?

Ans :

Polychromatic light consists of many colours each having its characteristic wavelength. White light is polychromatic light because white light is made up of seven colours.

214. Give the range of the wavelength of those electromagnetic waves which are visible to us.

Ans : SQP 2015

780 nm - 400 nm (7800 Å – 4000 Å)

215. A monochromatic beam of light of wavelength λ passes from air into a glass block. Write an expression to show the relation between the speed of light in air and the speed of light in glass.

Ans :

Refractive index,

$$\mu = \frac{\text{Speed of light in air } (v_a)}{\text{Speed of light in glass } (v_g)}$$

216. As the ray of light passes from air to glass, state how the wavelength of light changes. Does it increase, decrease or remain constant?

Ans : SQP 2022

Wavelength, λ decreases.

NODIA
NO NEED TO PURCHASE SAMPLE PAPERS
Download India's Best 20 Sample Papers
DOWNLOAD NODIA APP
Every School conduct Pre-Board
From These Sample Papers

$$\mu_g \sin i_2 = \mu_a \sin r_2$$

$$\frac{\mu_g}{\mu_a} = \frac{\sin r_2}{\sin i_2} \quad \text{...(ii)}$$

$$\frac{\mu_a}{\mu_g} = \frac{\sin i_2}{\sin r_2} = {}_g\mu_a \quad \text{...(iii)}$$

Now, Eq. (ii) and (iii), we get

$$\frac{\sin i_2}{\sin r_2} \times \frac{\sin r_2}{\sin i_2} = {}_a\mu_g \times {}_g\mu_a$$

$$1 = {}_a\mu_g \times {}_g\mu_a$$

$${}_a\mu_g = \frac{1}{{}_g\mu_a}$$

From Eq. (i) and (iii), we have

$$\frac{\sin i_1}{\sin r_1} = \frac{\sin r_2}{\sin i_2}$$

As, $\angle i_2 = \angle r_1$ (alternate angle)

Hence, $\sin i_2 = \sin r_1$ ...(iv)

From equation (iv), we get

$$\sin i_1 = \sin r_2$$

$$i_1 = r_2$$

Hence, angle of incidence = angle of emergence

Reason given for the statement in assertion is correct.

Thus (a) is correct option.

161. **Assertion :** Refractive indices of all transparent mediums are more than 1 (except air).

Reason : Air is the rarest medium.

(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(c) Assertion is true but Reason is false.

(d) Both Assertion and Reason are false.

Ans :

Refractive index of any medium is defined as the ratio of speed of light in air or vacuum to speed of light in given medium. Since speed of light is maximum in air (as vacuum), so air is the rarest medium. Hence both assertion and reason are true.

Thus (a) is correct option.

162. **Assertion :** When light travels from one medium to another. The direction of propagation of light in second medium changes.

Reason : Light travels with different speeds in different mediums.

(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(c) Assertion is true but Reason is false.

(d) Both Assertion and Reason are false.

Ans :

When light travels form one transparent medium to another then due to change in speed of light, its direction changes. Either light ray bends towards the normal or it bends away from the normal. Hence, both assertion and reason are true.

Thus (a) is correct option.

163. **Assertion :** After refraction though a rectangular glass slab, emergent ray is parallel to the direction of incident ray.

Reason : Refractive indices of air and glass are different.

(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(c) Assertion is true but Reason is false.

(d) Both Assertion and Reason are false.

Ans :

After refraction through a rectangular glass slab, emergent ray is parallel to the direction of incident are as opposite sides of rectangular glass slab performing refraction of light ray are parallel to each other. Also refractive indices of air and glass are different but this is not the cause of emergent ray being parallel to direction of incident ray. Hence, both assertion and reason are true but reason is not the correct explanation of assertion.

Thus (b) is correct option.

164. **Assertion :** On moving from optically rarer to denser medium, a ray of light bends away from the normal.

Reason : Speed of light is more in denser medium and less in rarer medium.

(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(c) Assertion is true but Reason is false.

(d) Both Assertion and Reason are false.

Ans :

Click Here to Buy book on Amazon

When a light ray travels from optically rarer to optically denser medium, it bends towards the normal due to decrease in speed of light. Hence, both assertion and reason are false.
Thus (d) is correct option.

165. **Assertion :** When light from sun is focussed on a sheet of paper using a convex lens, the paper begins to burn producing smoke. It may even catch fire after a while.
Reason : Convex lens is a converging lens.
(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(c) Assertion is true but Reason is false.
(d) Both Assertion and Reason are false.

Ans :

Due to converging nature of convex lens. Light rays coming from sun are converged at one point after passing through convex lens and due to this the paper begins to burn. Hence, both assertion and reason are true.
Thus (a) is correct option.

166. **Assertion :** Power of a convex lens is positive and that of a concave lens is negative.
Reason : Convex lens forms real image and concave lens forms virtual image.
(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(c) Assertion is true but Reason is false.
(d) Both Assertion and Reason are false.

Ans :

Power is expressed as

$$P = \frac{1}{f(\text{in meters})}$$

Focal length of convex lens is positive and focal length of concave lens is negative. So, assertion is true but reason is false.
Thus (c) is correct option.

167. **Assertion :** A small source of light casts a sharp shadow of an opaque object.
Reason : Light travels in straight lines.
(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(c) Assertion is true but Reason is false.
(d) Both Assertion and Reason are false.

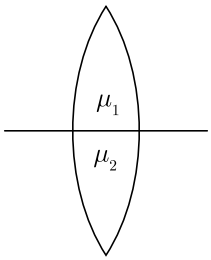
Ans :

Due to rectilinear propagation of light, when light falls on an opaque object casts its shadow. Hence, both assertion and reason are true.
Thus (a) is correct option.

NODIA

ONE MARK QUESTIONS

168. Refer to the diagram given below. A lens with two different refractive indices is shown. If the rays are coming from a distant object, then how many images will be seen?



Ans : SQP 2025

2 images will be formed.

169. A glass lens always forms a virtual, erect and diminished image of an object kept in front of it. Identify the lens.

Ans : SQP 2025

Concave lens.

170. In a reading glass what is the position of the object with respect to the convex lens used?

Ans : MAIN 2024

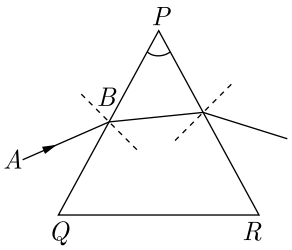
In between optical centre and focus.

171. Why can we not use concave lens for the same purpose?

Ans : MAIN 2024

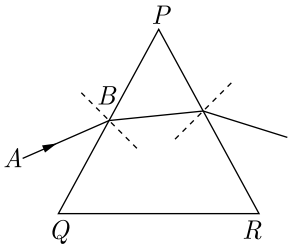
Because concave lens produces reduced size image.

172. Complete the path of the monochromatic light ray AB incident on the surface PQ of the equilateral glass prism due to refraction.



Ans : COMP 2020

The path of the rays is as shown :



173. Name one factor that affects the lateral displacement of light as it passes through a rectangular glass slab.

Ans : MAIN 2015

Factors that affect the lateral displacement of light as it passes through a rectangular glass slab are angle of incidence, refractive index of glass, colour (or wavelength) of light and thickness of glass slab.

174. State the relation between the critical angle and the absolute refractive index of a medium.

Ans : MAIN 2018

$$n = \frac{1}{\sin C}$$

175. Which colour of light has a higher critical angle? Red light or Green light.

Ans : MAIN 2018

Red

176. A ray of light passes from water to air. How does the speed of light change?

Ans :

The speed of light increases as it passes from water to air.

177. Which colour of light travels fastest in any medium except air?

Ans : MAIN 2014

The red colour of light will travel the fastest in any medium.

NODIA

178. Why do the clouds appear white?

Ans : SQP 2010

Dust particles and water droplets present in the atmosphere do not obey Rayleigh's scattering law. They scatter all the colours almost equally. Thus the clouds appear white.

179. Why are the danger signals red?

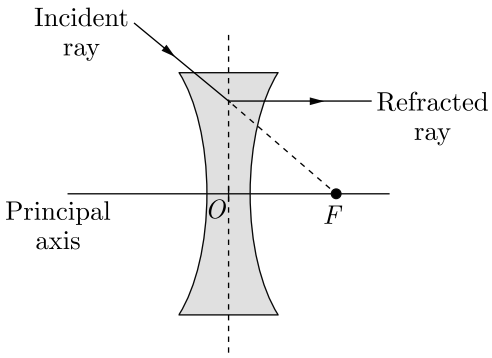
Ans : COMP 2008

The scattering of light is found to be inversely proportional to the fourth power of the wavelength of light. Thus scattering of red light is very much less than that of yellow light ($\lambda_r > \lambda_v$). Therefore red light signals can be seen up-to a longer distance. This is why danger signals are red.

180. A ray of light after refraction through a concave lens emerges parallel to the principal axis. Draw a ray diagram to show the incident ray and its corresponding emergent ray.

Ans : MAIN 2003

The ray diagram is as shown below :



181. Why are infrared radiations preferred over ordinary visible light for taking photographs in fog?

Ans : SQP 2003

Infrared radiations are used for photography in fog because they are not much scattered by mist or fog and therefore, they can penetrate appreciably through it.

182. A ray of light is incident normally on a plane glass slab. What will be the angle of refraction and the angle of deviation for the ray?

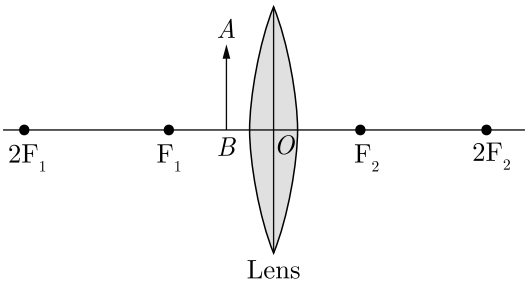
Ans : COMP 2002

222. (i) Define critical angle.
(ii) State one important factor which affects the critical angle of a given medium.

Ans : COMP 2019

(i) It is the angle of incidence in the denser medium for which angle of refraction in the rarer medium is 90°.
(ii) Nature of the two media in contact.

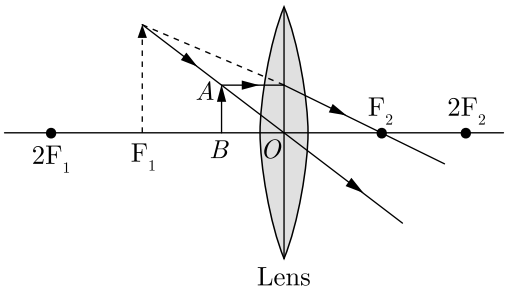
223. An object AB is placed between O and F_1 on the principal axis of converging lens as shown in the diagram.



Copy the diagram and by using three standard rays starting from point A, obtain an image of the object AB.

Ans : COMP 2018

The figure is as shown :



224. (i) What is the relation between the refractive index of water with respect to air $({}_a\mu_w)$ and the refractive index of air with respect to water $({}_w\mu_a)$.
(ii) If the refractive index of water with respect to air $({}_a\mu_w)$ is $\frac{5}{3}$. Calculate the refractive index of air with respect to water $({}_w\mu_a)$.

Ans : MAIN 2019

(i) The relation is ${}_a\mu_w = \dfrac{1}{{}_w\mu_a}$

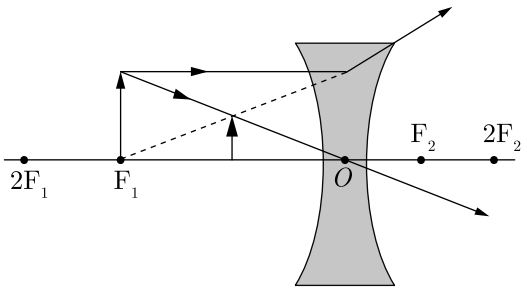
(ii) Given, ${}_w\mu_a = \dfrac{5}{3}$,

$${}_w\mu_a = \frac{1}{{}_a\mu_w} = \frac{1}{\frac{5}{3}} = \frac{3}{5}$$

225. A virtual, diminished image is formed when an object is placed between the optical centre and the principal focus of a lens.
(i) Name the type of lens which forms the above image.
(ii) Draw a ray diagram to show the formation of the image with the above stated characteristics.

Ans : SQP 2019

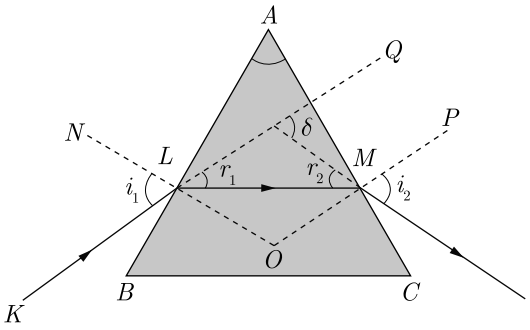
(i) Concave lens.
(ii) The ray diagram is as shown :



226. Draw a ray diagram to show the refraction of a monochromatic ray through a prism when it suffers minimum deviation.

Ans : SQP 2017

The ray diagram is as shown below :



227. A boy uses blue colour of light to find the refractive index of glass. He then repeats the experiment using red colour of light. Will the refractive index be the same or different in the two cases? Give a reason to support your answer.

Ans : MAIN 2016

To find the refractive index of glass if different coloured lights (blue and red) are used, the refractive indices will be different in the two cases. This is because the refractive index, μ of the material of the prism depends on wavelength (λ) of light as $\mu = A + \dfrac{B}{\lambda^2} + \dfrac{C}{\lambda^4} + \ldots$ where A, B

Downloaded from www.pdf.tube

Welder wears a mask because it has a filter which absorbs harmful ultraviolet radiations coming from the welding arc.

195. Why does a converging lens behave as a 'burning glass'?

Ans : MAIN 2000

When the rays from the sun which is at infinity are brought to focus on a piece of paper, due to sufficient heat of the sun rays, the paper burns.

196. How does the speed of light in glass change on increasing the wavelength of light?

Ans : COMP 2020

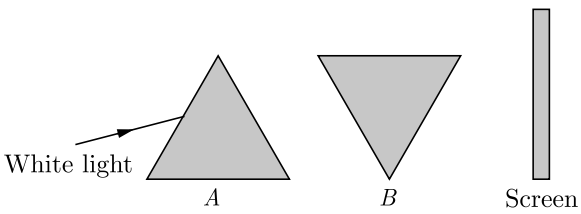
Speed of light in glass increases on increasing the wavelength of light.

197. A ray of light is incident normally on a plane glass slab. What will be the angle of refraction and the angle of deviation for the ray ?

Ans : SQP 2023

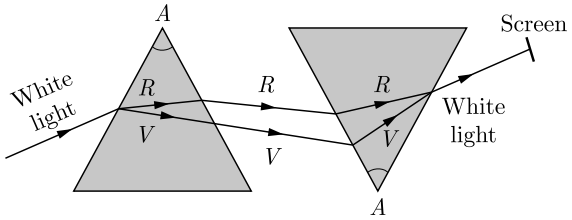
If ray is incident perpendicular to the surface separating the two media, it passes undeviated, i.e., if $\angle i = 0, \angle r = 0$ and angle of deviation is also zero.

198. Copy the diagram given below and complete the ray diagram to show the nature of light produced on the screen.

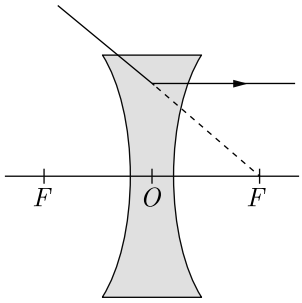


Ans :

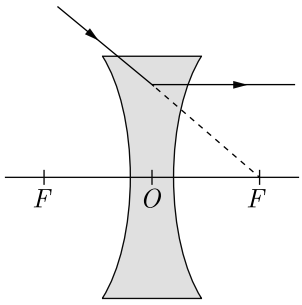
The complete diagram is as shown in the figure given below.



199. Copy the diagram and complete it by drawing the corresponding incident ray.



Ans : COMP 2002



200. Is it possible for a lens to act as a convergent lens in one medium and a divergent lens in another?

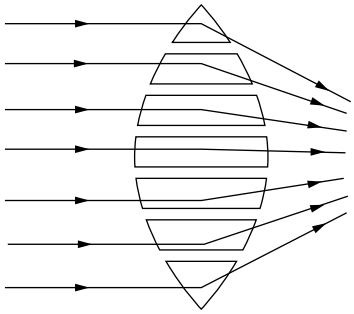
Ans : SQP 2001

Yes, the type of lens changes, if it is placed in a medium having a higher refractive index than that of material of the lens.

201. Draw a diagram to show the convergent action of a converging lens by treating it as a combination of prisms with the bases towards the centre of the lens.

Ans : MAIN 2008

The diagram is as shown alongside :



202. State the characteristics of the virtual image formed by a convex lens.

Ans : COMP 2009

Upright and magnified

NODIA

If a ray is incident perpendicular to the surface separating the two media, it passes undeviated, i.e. if $\angle i = 0$, $\angle r = 0$ and angle of deviation is also zero.

183. Can a glass slab disperse light? If not, why?

Ans : MAIN 2022

No, when the white light is incident on the glass slab, it disperses the white light into different colours but these different colours combine to form white light on emerging from the other parallel face.

184. Which of the colours of the spectrum of white light is deviated and refracted (i) least and (ii) most?

Ans : SQP 2006

Violet colour is refracted the most and the red the least, that is why the violet colour is deviated the maximum and the red colour is deviated the least.

185. How does the speed of light in glass change on increasing the wavelength of light?

Ans : MAIN 2002

Speed of light in glass increases on increasing the wavelength of light.

186. Why does the sky appear blue?

Ans : SQP 2017

The scattering of light depends upon the wavelength of light. The wavelength of red colour is more than the wavelength of violet colour so the blue colour is scattered more than the red colour. Due to scattering of blue light in different directions, the sky appears blue.

187. Rock salt prism is used instead of glass prism to obtain infrared spectrum. Explain why.

Ans : COMP 2010

Rock salt prism is used instead of glass prism to obtain infrared spectrum because infrared radiations are absorbed by glass but not by rock-salt.

188. State Snell's law of refraction of light.

Ans : MAIN 2016

According to Snell's law, the ratio of the sine of the angle of incidence and sine of the angle of refraction is equal to a constant for the same pair of media. This constant ratio is called the refractive index of the second medium with respect to the first. It is represented by Greek letter μ (mew).

189. What do you mean by visible and invisible spectrum?

Ans : COMP 2019

The regions of spectrum which excite retina and hence are visible collectively are called visible spectrum. On the other hand, the regions of spectrum which do not excite retina and hence are not visible are called invisible spectrum.

190. Why dark rooms are provided with infrared lamps for photography?

Ans : SQP 2015

For photography, dark rooms are provided with infrared lamps because they do not affect ordinary photographic film however they affect a specially treated photographic film.

191. Does a beam of white light give a spectrum on passing through a hollow prism?

Ans : MAIN 2002

No, hollow prism contains air and dispersion does not take place through a hollow prism.

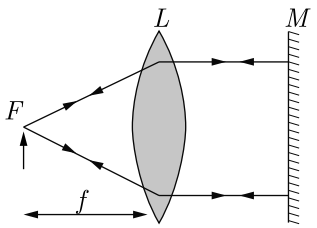
192. Arrange the following radiations in the ascending order of their frequency. Visible light, light-wave, infrared radiation, ultraviolet rays, γ-rays, X -rays, radio-waves, microwaves.

Ans : COMP 2010

Radio-waves, microwaves, infra-red radiation, visible light, ultraviolet radiation, X-rays, γ-rays.

193. Draw a ray diagram to illustrate the determination of the focal length of a convex lens using an auxiliary plane mirror.

Ans : SQP 2020



194. Why does a welder wear a mask?

Ans : COMP 2011

Click Here to Buy book on Amazon

TWO MARKS QUESTIONS

217. When sunlight passes through water droplets in the atmosphere it gets dispersed into its constituent colours forming a rainbow. A similar phenomenon is observed when white light passes through a prism.
(a) Which colour will show the maximum angle of deviation and which colour will show the minimum angle of deviation?
(b) If Instead of sunlight, a green-coloured ray is passed through a glass prism. What will be the colour of the emergent ray?

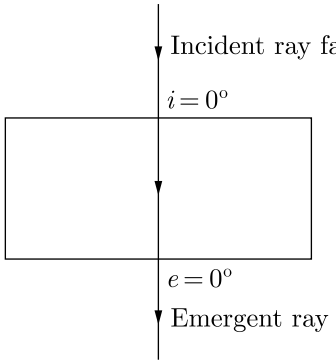
Ans : SQP 2025

(a) Violet shows maximum angle of deviation red shows minimum angle of deviation.
(b) Green

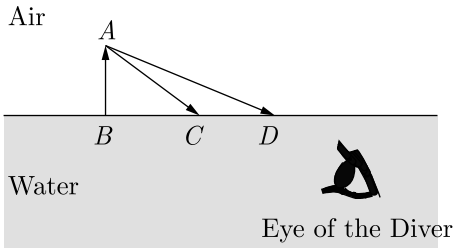
218. A ray of light falls normally on a rectangular glass slab. Draw a ray diagram showing the path of the ray till it emerges out of the slab.

Ans : COMP 2020

The ray diagram is as shown :



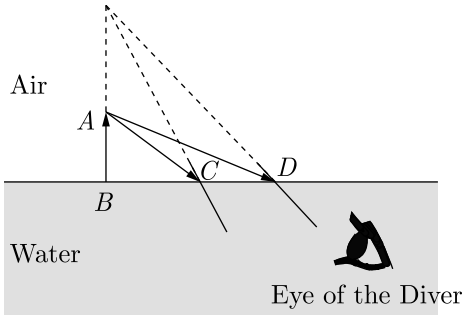
219. A diver in water looks obliquely at an object AB in air.



(i) Does the object appear taller, shorter or of the same size to the diver?
(ii) Show the path of two rays AC and AD starting from the tip of the object as it travels towards the diver in water and hence obtain the image of the object.

Ans : MAIN 2020

(i) Taller.
(ii) The diagram is as shown :

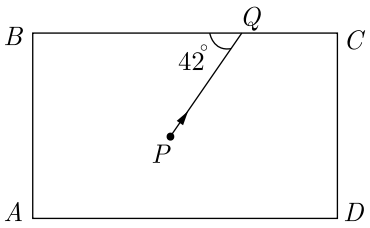


220. Where should an object be placed in front of a convex lens in order to get (i) an enlarged real image, (ii) enlarged virtual image ?

Ans : SQP 2010

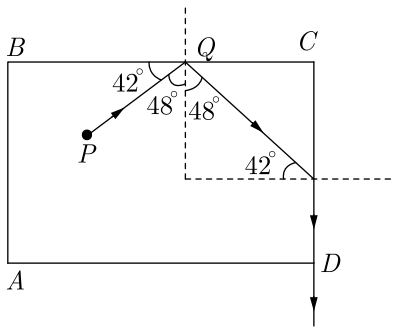
(i) Beyond 2F
(ii) Between optical centre and the focus.

221. The diagram below shows a light source P embedded in a rectangular glass block $ABCD$ of critical angle 42°. Complete the path of the ray PQ till it emerges out of the block. [Write necessary angles.]



Ans : SQP 2019

The path of ray is as shown below :



NODIA

Infrared radiation is used for photography at night.
Thus (b) is correct option.

154. A plane passing through the second focal point and ..... to principal axis is called second focal plane.
(a) Perpendicular (b) Parallel
(c) Opposite (d) All of these

Ans : MAIN 2020

Thus (a) is correct option.

155. 1 Angstroms unit (Å) is equal to :
(a) 10^{-8} m (b) 10^{-6} m
(c) 10^{-10} m (d) 10^{-12} m

Ans : COMP 2000

Thus (c) is correct option.

156. An isosceles totally reflecting prism can reflect rays through an angle of :
(a) 90° (b) 60°
(c) 180° (d) both (b) and (c)

Ans : COMP 2003

Thus (d) is correct option.

157. ..... rays do not scatter easily in fog.
(a) Infrared (b) Ultraviolet
(c) Red (d) Green

Ans : COMP 2015

The red light has the largest wavelength among all visible parts of light and so it is scattered the least by the fog of smoke. Scattering of light is more effective in blue, yellow, and green due to their shorter wavelengths. The red is deviated least and the violet is most.
Thus (a) is correct option.

158. A lens forms an upright and magnified image an object, Name the lens.
(a) concave (b) convex
(c) bi-concave (d) plano-convex

Ans : SQP 2020

Since lens forms an upright and magnified image of an object, the lens used here is a convex lens.
Thus (b) is correct option.

FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

ASSERTION AND REASON

159. **Assertion :** Ultraviolet radiations are scattered more as compared to the microwave radiations.
Reason : Wavelength of ultraviolet radiation is more than the wavelength of microwave radiation.
(a) Both Assertion and Reason are true.
(b) Assertion is true but Reason is false.
(c) Assertion is false but Reason is true.
(d) Both Assertion and Reason are false.

Ans : MAIN 2024

$$\text{Scattering of light} \propto \frac{1}{\text{Wave length of light}}$$

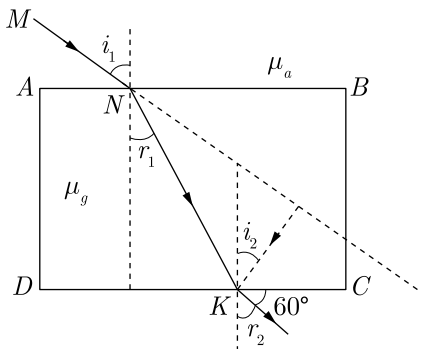
Wavelength of ultraviolet is less than the wavelength of microwave. Hence, scattering of ultraviolet is more than that of microwave.
Thus (b) is correct option.

160. **Assertion :** In case of refraction of light through glass slab, angle of incidence is equal to angle of emergence.
Reason : A glass slab is cuboid made of glass in which refraction occurs twice from the corresponding parallel surfaces.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) Reason is true, but assertion is false.
(d) Assertion is true, but reason is false.

Ans : MAIN 2006

In case of refraction of light through glass slab,

$$\angle i = \angle e$$



Applying Snell's law at N,

$$\mu_a \times \sin i_1 = \mu_g \times \sin r_1$$

$$\frac{\sin i_1}{\sin r_1} = \frac{\mu_g}{\mu_a} = {}_a\mu_g \qquad \text{...(i)}$$

Again, applying Snell's law at K,

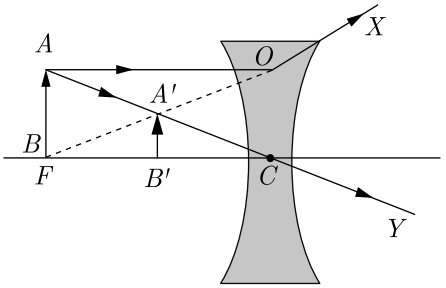
Downloaded from www.pdf.tube

and C are constants. As $\lambda_r > \lambda_b$ therefore, the refractive index m of the material of the prism will be different for different colours, i.e. $\mu_{\text{blue}} > \mu_{\text{red}}$.

228. A lens forms an upright and diminished image of an object when the object is placed at the focal point of the given lens.
(i) Name the lens.
(ii) Draw a ray diagram to show the image formation.

Ans : COMP 2017

(i) Concave lens.
(ii) The diagram is as shown below :

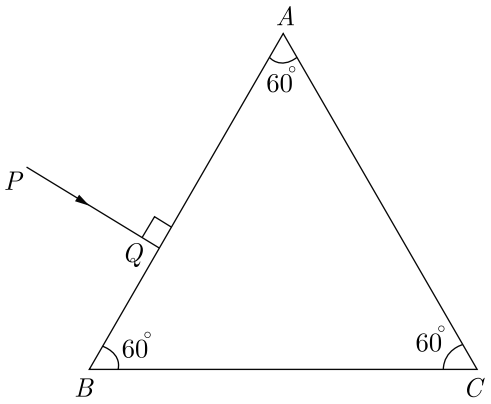


229. State the dependence of angle of deviation :
(i) On the refractive index of the material of the prism.
(ii) On the wavelength of light.

Ans : COMP 2016

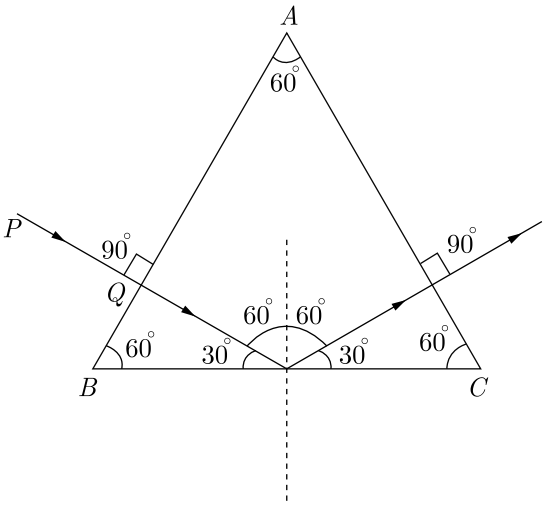
(i) Directly proportional to the refractive index of the material of the prism.
(ii) Inversely proportional to the wavelength of light used.

230. Copy the diagram given below and complete the path of light ray till it emerges out of the prism. The critical angle of glass is 42°. In your diagram mark the angles wherever necessary.



Ans : SQP 2016

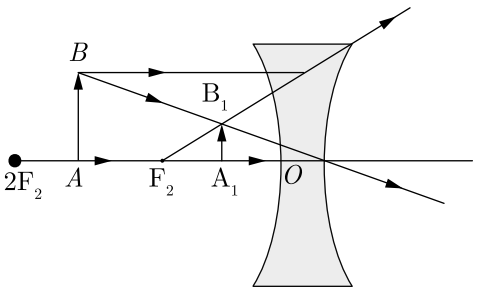
The diagram is as shown :



231. A lens produces a virtual image between the object and the lens.
(i) Name the lens.
(ii) Draw a ray diagram to show the formation of this image.

Ans : MAIN 2016

(i) Concave lens.
(ii) The ray diagram is as shown below :



232. What do you understand by the term 'Scattering of light'? Which colour of white light is scattered the least and why?

Ans : SQP 2016

When sunlight travels through earth's atmosphere it gets scattered on interacting with matter particles through any combination of following processes viz. reflection, absorption and re-radiation.
According to Rayleigh's scattering law, the amount of scattering is inversely proportional to the fourth power of the wavelength (λ). This is why the red light of longest wavelength scatters least.

NODIA

Yes. It can be done by focussing sun rays on a paper with the help of a convex lens. When the rays of sun are passed through the convex lens and paper is placed at its focus F the paper will catch fire because the heat rays of the sun are also focussed.

280. A glass slab is placed over a piece of paper on which VIBGYOR is printed with each letter into its corresponding colours.

(i) Will the image of all the letters be in the same place ?

(ii) The letter of which colour appears to be raised maximum and of which colour minimum? Explain your answer.

Ans : COMP 2007

(i) The image of all the letters will not be in the same place.

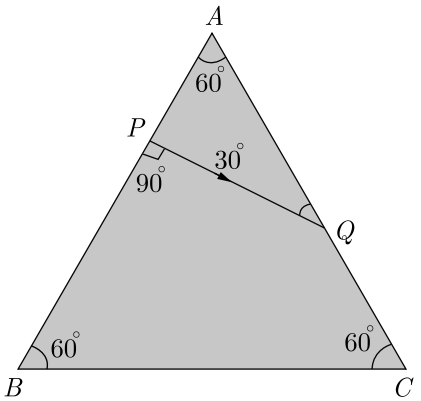
(ii) The letter of violet colour (i.e., V) appears to be raised maximum, while the letter of red colour (i.e., R) appears to be raised minimum.
Since apparent depth $= \dfrac{\text{real depth}}{\text{refractive index}}$ and refractive index of glass is most for the violet light while least for the red light, therefore, the apparent depth is least for violet and most for the red.

281. Why are infrared radiations used as signals during war?

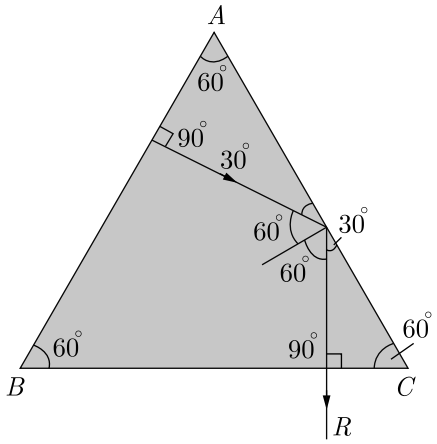
Ans : MAIN 2017

Infrared radiations are used as signals during war because of their longer wavelength as they are scattered less by atmosphere and also intensity of scattered radiation $\propto \dfrac{1}{\lambda^4}$.

282. Complete the path of the ray from Q onwards in the adjoining figure of a glass prism.



Ans : SQP 2022



283. (a) Can the absolute refractive index of a medium be less than one?

(b) A coin placed at the bottom of a beaker appears to be raised by 4.0 cm. If the refractive index of water is 4/3, find the depth of the water in the beaker?

Ans : MAIN 2023

(a) No, because refractive index $= \dfrac{c}{v}$, where speed of light in vacuum $3 \times 10^8\ \text{ms}^{-1}$ is always greater than speed of light in any medium. Therefore, refractive index is always greater than 1.

(b) Let the real depth of coin be x.
Refractive index of glass

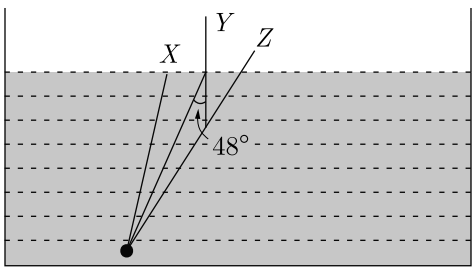
$$= \frac{\text{Real depth of coin}}{\text{Apparent depth of coin}}$$

$$\frac{4}{3} = \frac{x}{x-4}$$

$$4(x-4) = 3x$$

$$x = 16\ \text{cm}$$

284. The diagram shows a point source P inside a water tank. Path of the three rays X, Y and Z into the water is shown in the diagram. If the critical angle for water-air pair is 48° show the path of these rays after striking the water surface.



Ans : COMP 2001

Click Here to Buy book on Amazon

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

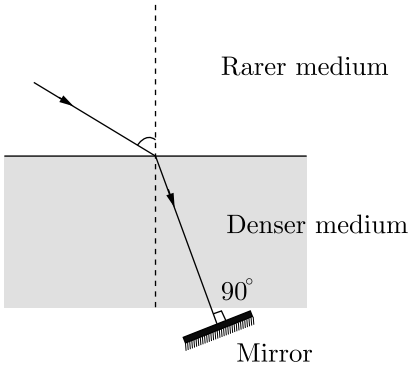
Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!

(ii) By using silver chloride solution.

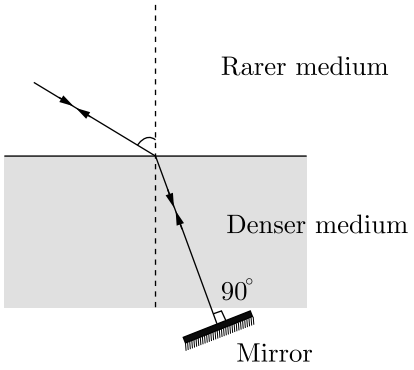
241. A ray of light is moving from a rarer medium to a denser medium and strikes a plane mirror placed at 90° to the direction of the ray as shown in the diagram.



(a) Copy the diagram and mark arrows to show the path of the ray of light after it is reflected from the mirror.
(b) Name the principle you have used to mark the arrows to show the direction of the ray.

Ans : COMP 2013

(a)



(b) Principle of reversibility of the path of light.

242. Ranbir claims to have obtained an image twice the size of the object with a concave lens. Is he correct? Give a reason for your answer.

Ans : SQP 2014

No, he is not correct.
Magnified image of an object cannot be formed by a concave lens ever. Because, no matter where the object is placed in front of a concave lens, it always forms a virtual, erect and diminished image of the object.

243. A ray of light incident at an angle of incidence i passes through an equilateral glass prism such that the refracted ray inside the prism is parallel to its base and emerges from the prism at an angle of emergence e.
(a) How is the angle of emergence e related to the angle of incidence i ?
(b) What can you say about the value of the angle of deviation in such a situation?

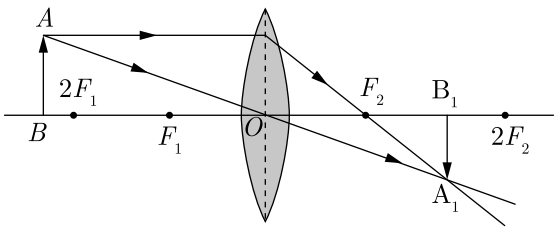
Ans : MAIN 2012

(a) Angle of incidence, i is equal to the angle of emergence, e i.e., $\angle i = \angle e$
(b) When the refracted ray inside the prism is parallel to its base, the angle of deviation is minimum in such a situation.

244. A converging lens is used to obtain an image of an object placed in front of it. The inverted image is formed between F_2 and $2F_2$ of the lens.
(a) Where is the object placed?
(b) Draw a ray diagram to illustrate the formation of the image obtained.

Ans : SQP 2012

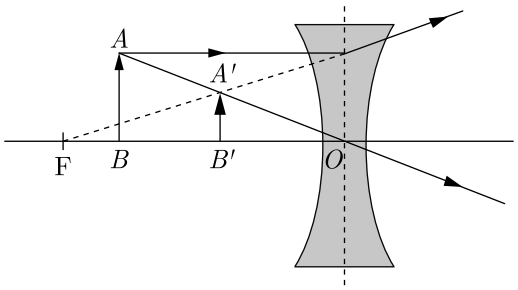
(a) The object is placed beyond $2F_1$
(b)



245. An object is placed in front of a lens between its optical centre and the focus and forms a virtual, erect and diminished image.
(i) Name the lens which formed this image.
(ii) Draw a ray diagram to show the formation of the image with the above stated characteristics.

Ans : SQP 2011

(i) Concave lens.
(ii)



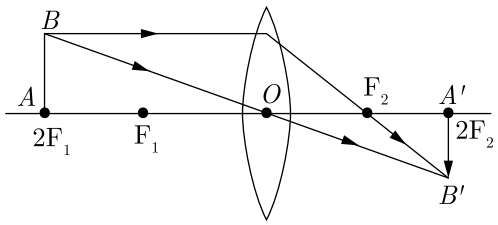
Concave lens

Downloaded from www.pdf.tube

233. (i) Where should an object be placed so that a real and inverted image of the same size as the object is obtained using a convex lens ?
(ii) Draw a ray diagram to show the formation of the image as specified in the part (i).

Ans : COMP 2015

(i) At 2F.
(ii) The ray diagram is as shown below :



234. (a) Name the high energetic invisible electromagnetic waves which help in the study of the structure of crystals.
(b) State an additional use of the waves mentioned in part (a).

Ans : MAIN 2015

(a) X-rays help in the study of the structure of crystals.
(b) X-rays are also used to detect the fracture in bones.

235. Name the factors affecting the critical angle for the pair of media.

Ans : SQP 2014

Factors affecting the critical angle are :
(i) **Colour (or wavelength) of light :** The refractive index of a transparent medium is most for violet light and least for red light, therefore, the critical angle for a pair of media is least for violet light and most for red light. Thus, the critical angle increases with increase in wavelength of light.
(ii) **Temperature :** On increasing the temperature of the medium, its refractive index decreases, so the critical angle for that pair of media increases. Thus, the critical angle increases with increase in temperature.

236. State the position of the object in front of a converging lens if :
(i) It produces a real and same size image of the object.
(ii) It is used as a magnifying lens.

Ans : COMP 2018

(i) 2F
(ii) Between F and 2F

237. How is the refractive index of a material related to :
(i) real and apparent depth ?
(ii) velocity of light in vacuum or air and the velocity of light in a given medium ?

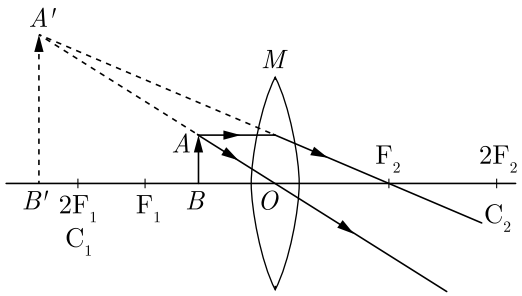
Ans : SQP 2010

(i) $\mu = \dfrac{\text{real depth}}{\text{apparent depth}}$ and
(ii) $\mu = \dfrac{c}{v}$

238. A lens forms an erect, magnified and virtual image of an object.
(i) Name the lens.
(ii) Draw a labelled ray diagram to show the image formation.

Ans : COMP 2014

(i) **Convex lens,** When object is placed between focus F and optical centre O of a convex lens, it forms a magnified, virtual and erect image on the same side of the lens.
(ii) The ray diagram is as shown below :



239. State the conditions required for total internal reflection of light to take place.

Ans : MAIN 2017

(i) The incident ray should travel from the denser to the rarer medium.
(ii) The angle of incidence in the denser medium should be greater than the critical angle for the given pair of media.

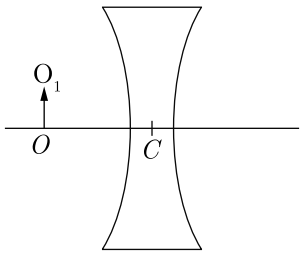
240. Suggest one way, in each case, by which we can detect the presence of:
(i) Infrared radiations.
(ii) Ultraviolet radiations.

Ans : MAIN 2011

(i) By using a thermopile or a blackened bulb thermometer.

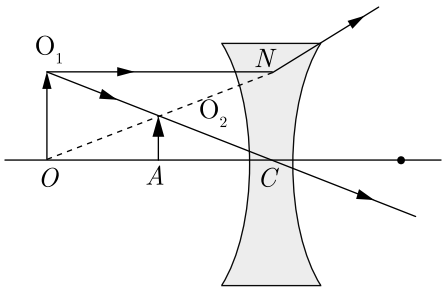
NODIA

the image formed by the lens.



Ans : MAIN 2001

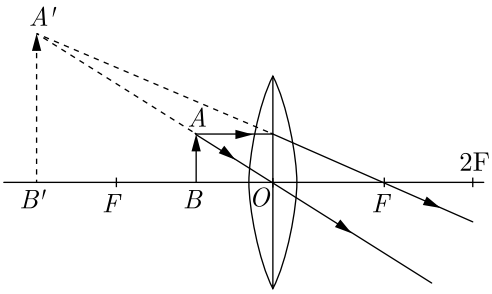
The ray diagram is as shown below :



252. Draw a ray diagram to illustrate the action of a convergent lens as reading glasses or magnifying glass.

Ans : SQP 2000

The ray diagram is as shown below :



253. What is an optical fibre ?Give one practical use of an optical fibre.

Ans : COMP 2002

Optical fibre is a fine quality fibre of glass or quartz. Its diameter is of the order of 10^{-4} cm with refractive index of material being of the order of 1.7. Optical fibres are coated with a thin layer of 1.5.

Optical fibre is used in telephone and other transmitting cables.

254. Why does the Sun appear red at sunrise?

Ans : MAIN 2009

In the early morning, sun is near the horizon. The light has to travel through thicker layer of air and longer distance in the earth's atmosphere. Hence, most blue light and shorter wavelengths are scattered away by the particles in the earth's atmosphere before reaching our eyes. Hence, the light of longer wavelengths reaches our eyes which gives rise to the reddish appearance of the sun.

255. A glass slab is placed over a page in which VIBGYOR is printed where every letter is printed with its corresponding colour. Will the image of all the letters lie in the same plane? If not which letter will appear to be raised maximum?

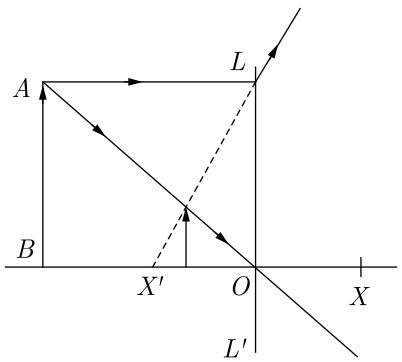
Ans : COMP 2011

No, As we know,

$$\mu = \frac{\text{real depth}}{\text{apparent depth}} \text{ and } \mu_v > \mu_r,$$

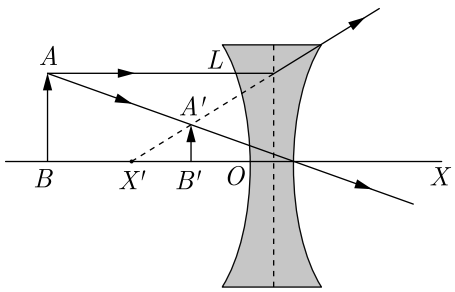
violet letter image will be raised maximum.

256. (a) Copy and complete the diagram to show the formation of the image of the object AB.
(b) What is the name given to X?



Ans : MAIN 2005

(a)



(b) In figure, X-First principal focus.

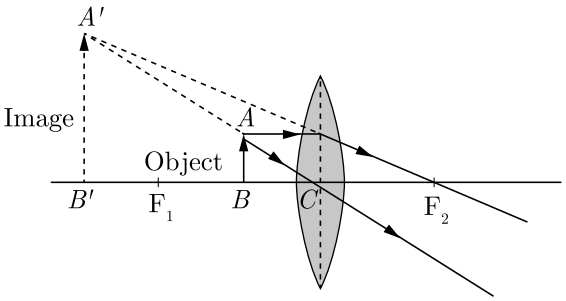
257. What is meant by
(a) critical angle;
(b) total internal reflection?

Click Here to Buy book on Amazon

246. Erect, magnified and virtual image is formed, when an object is placed between the optical centre and principal focus of a lens.
(a) Name the lens.
(b) Draw a ray diagram to show the formation of the image with the above stated characteristics.

Ans : MAIN 2010

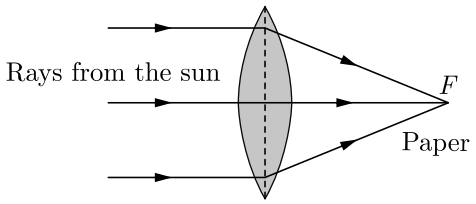
(a) Convex lens
(b)



247. We can burn a piece of paper by focusing the sun rays by using a particular type of lens.
(i) Name the type of lens used for the above purpose.
(ii) Draw a ray diagram to support your answer.

Ans : SQP 2010

(i) A convex lens is used to focus the sun rays on a piece of paper to burn a piece of paper. A large amount of heat gets concentrated at a point and is sufficient to burn the piece of paper.
(ii) The necessary ray diagram is given below :

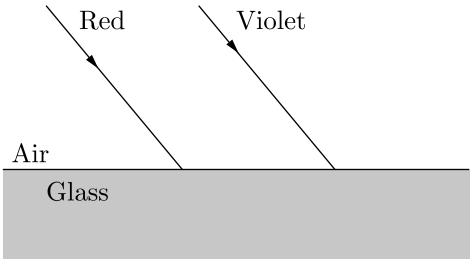


248. State the characteristics of the image of an extended source, formed by a concave lens.

Ans : COMP 2003

The image of an extended source, as formed by a concave lens, has the following characteristics:
(i) smaller in size than the source itself,
(ii) a virtual image and
(iii) an erect image.

249. Two parallel rays of Red and Violet colour travelling through air, meet the air-glass boundary as shown in the figure :



(a) Will their paths inside the glass be parallel? Give a reason for your answer.
(b) Compare the speeds of the two rays inside the glass.

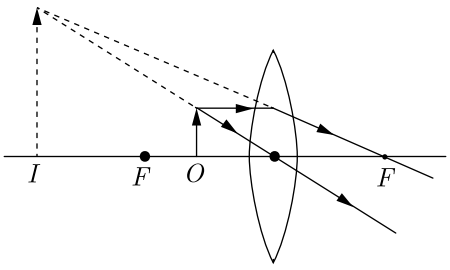
Ans : COMP 2010

(a) No, the paths of two parallel rays of red and violet colour travelling through glass will not be parallel because on entering the glass both rays deviate to different extents.
(b) $v_{\text{violet}} < v_{\text{red}}$

250. The diagram given below shows an object O and its image I. Copy the diagram and draw suitable rays to locate the lens and its focus. Name the type of lens in this case.

Ans : SQP 2004

The lens is a convex lens. The ray diagram is as shown below. Since the image is virtual, therefore, the lens must be situated on one side of the object and image.



251. In the given figure, $OC = f$, the focal length of the lens. Copy the diagram in your answer book. Draw rays from the linear object OO_1 and obtain

NODIA

ratio given by equation is called absolute refractive index of medium 2. Absolute refractive index can also be defined in terms of speed of light, i.e., the ratio of speed of light in vacuum to the speed of light in the medium is called the refractive index of the medium.

So, the absolute refractive index of the medium,

$$\mu = \frac{\text{Speed of light in vacuum or air}}{\text{Speed of light in the medium}}$$

263. What rays exist beyond the visible-red end of the electromagnetic spectrum? State one use and one method of detecting these rays.

Ans : SQP 2023

Beyond visible-red end of electromagnetic spectrum, infra-red rays exist. Infra-red rays have wavelength greater than and frequency less than that of red light.

Use : Infra-red rays are very penetrating, hence infra-red cameras are used during foggy season and during war time by flying plane high enough to avoid attack by anti-aircraft guns.

Detection : Since they contain a good amount of heat rays, hence these can be detected by thermometer whose bulb is coated black. When the bulb is moved from violet to red, there is a large increase in temperature. This is due to heat contained in infra-red rays.

264. We can burn a piece of paper by focussing the sun rays by using a particular type of lens.

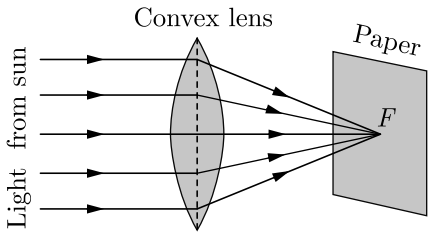
(a) Name the type of lens used for the above purpose.

(b) Draw a ray diagram to support your answer.

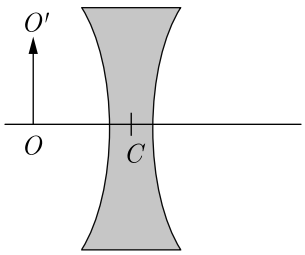
Ans : SQP 2011

(a) Convex lens

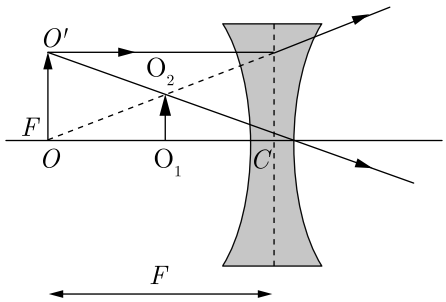
(b) Ray diagram



265. Given OC is equal to the focal length of the lens; copy the diagram in your answer book. Draw two rays from the linear object OO' and obtain the image formed by the lens.



Ans : COMP 2016



266. Where must an object be placed in front of a converging lens so that the image formed may be

(a) of the same size as the object,

(b) at infinity,

Ans : MAIN 2021

(a) at 2F

(b) at F

267. What do you mean by a pure and an impure spectrum? What is Newton's colour disc?

Ans : COMP 2011

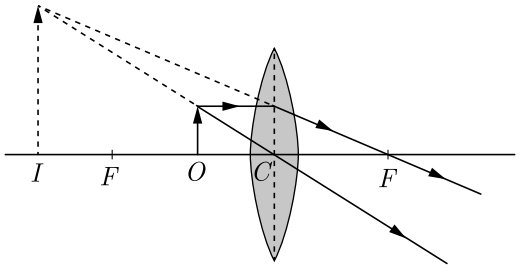
A spectrum in which various bands of colours have sharp well defined boundaries and do not overlap into each other is called pure spectrum while the spectrum in which different bands of colours have no sharp well defined boundaries but diffuse into each other is called impure spectrum.

268. The diagram given below shows an object O and its image I.

Copy the diagram and draw suitable rays to locate the lens and its focus. Name the type of lens in this case.

Ans : COMP 2011

Downloaded from www.pdf.tube



Convex lens

269. Light passes through a rectangular glass slab and through a triangular glass prism. In what way does the direction of the two emergent beams differ and why?

Ans : MAIN 2003

In a rectangular glass slab, the emergent ray is laterally displaced because the two refracting surfaces are parallel to each other.
In a triangular glass prism, the emergent ray is deviated because two refracting surfaces are inclined to each other at an angle.

270. Why does the sun appear reddish early in the morning?

Ans : MAIN 2005

In the early morning, sun is near the horizon. The light has to travel through thicker layer of air and longer distance in the earth's atmosphere. Hence most blue light and shorter wavelengths are scattered away by the particles in the earth's atmosphere before reaching our eyes. Hence the light of longer wavelengths reaches our eyes which gives rise to the reddish appearance of the sun.

271. Mention two properties and two uses of X-rays.

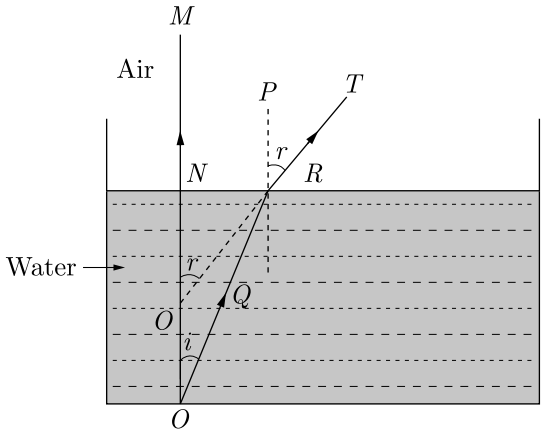
Ans : SQP 2002

Properties of X-rays:
(i) These are invisible rays.
(ii) These are electromagnetic rays, which travel with the speed of light.

Uses of X-rays:
(i) X-ray radio-graphs are used in surgery for detection of fractures, infected organs.
(ii) These are used in detecting flaws and cracks in metal sheets used in manufacture of aircraft.

272. Show through a properly labelled diagram that the apparent depth of water in its real depth. How is the refractive index of water related to real and apparent depth of the object in the water?

Ans : SQP 2007



Refractive index of water with respect to air

$$_a\mu_w = \frac{\text{Real depth}}{\text{Apparent depth}}$$

Real depth of the tank - NO
Apparent depth of the tank - NO'

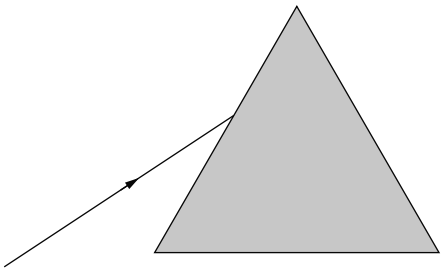
273. How does the value of angle of deviation produced by a prism change with an increase in the :
(a) value of angle of incidence?
(b) wavelength of incident light?

Ans : COMP 2018

(a) With the increase in the value of the angle of incidence, there is corresponding decrease in the angle of deviation for a particular value of angle of incidence, the angle of deviation becomes minimum after which it starts rising with further increase in the value of angle of incidence.
(b) With an increase in the wavelength of light used, angle of deviation decreases.

NODIA

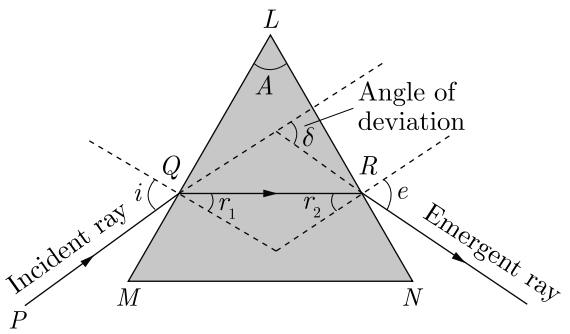
274. (a) The diagram below shows a ray of light incident on an equilateral glass prism placed in minimum deviation position.



Copy the diagram and complete it to show the path of the refracted ray and the emergent ray.
(b) How are angle of incidence and angle of emergence related to each other in this position of the prism?

Ans : COMP 2000

(a)

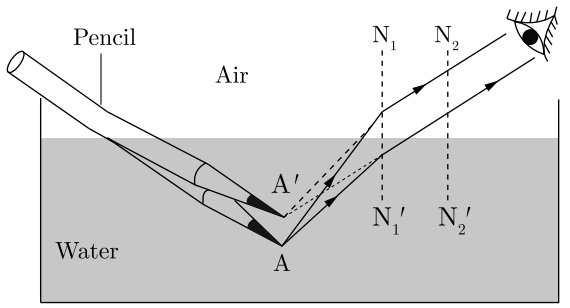


(b) $\angle i = \angle e$

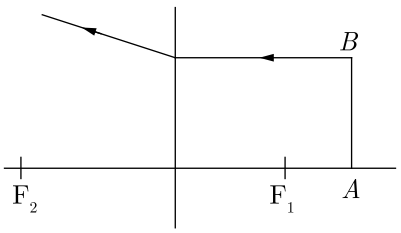
275. A pencil partially immersed in water in glass, appears bent. Explain with the help of a ray diagram.

Ans : SQP 2010

A pencil partially immersed in water in a glass container appears bent as shown in the figure because the rays appear to come from B due to refraction from denser medium (water) to rarer medium (air) at the surface separating two media.

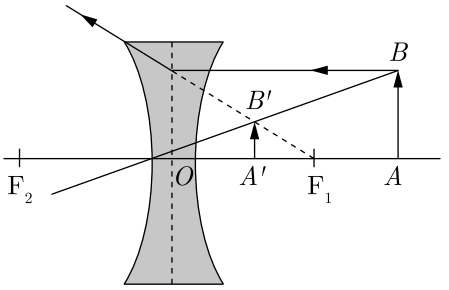


276. Copy the figure and complete it to show the formation of the image of the object AB. Name the lens used in the figure.



Ans : MAIN 2011

Since the ray is deviated away from the axis, the lens used is a concave lens. The complete figure showing the image formed is given above. The image is virtual, erect and diminished.



Concave lens

277. A harpoon used to kill a fish is aimed at a point below the apparent position of the fish. Why?

Ans : MAIN 2008

A harpoon used to kill a fish is aimed at a point below the apparent position of the fish because the fish appears to be raised up due to refraction of light from denser medium (water) to rarer medium (air) at the surface separating two media.

278. (a) A particular type of high energy invisible electromagnetic rays help us to study the structure of crystals. Name these rays and give another important use of these rays.

(b) How does the speed of light in glass change on increasing the wavelength of light?

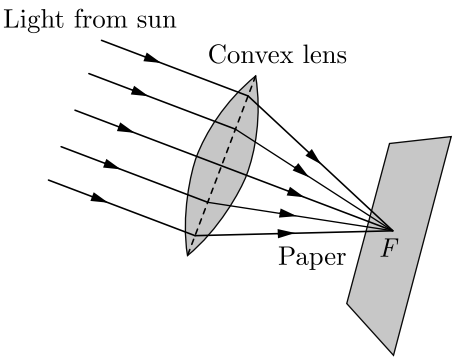
Ans : SQP 2005

(a) **X-rays :** X-ray radio-graphs are used in surgery for detection of fractures, infected organs.

(b) In a medium, the speed of light increases on increasing the wavelength of light, i.e. red light travels faster than the violet light.

279. Is it possible to burn a piece of paper using a convex lens in day-light without using matches or any direct flame? Draw a diagram to support your answer.

Ans : COMP 2014



Click Here to Buy book on Amazon

Ans : MAIN 2020

(a) Critical angle is the angle of incidence in the denser medium for which the angle of refraction in the rarer medium is 90°.

(b) When a ray coming from denser to rarer medium is incident at an angle greater than critical angle at denser-rarer interface, it is reflected back in the denser medium. This phenomenon is called total internal reflection.

258. Copy and complete the following table :

Types of lens	**Position of object**	**Nature of image**	**Size of image**
Convex	At F		
Concave	At infinity		

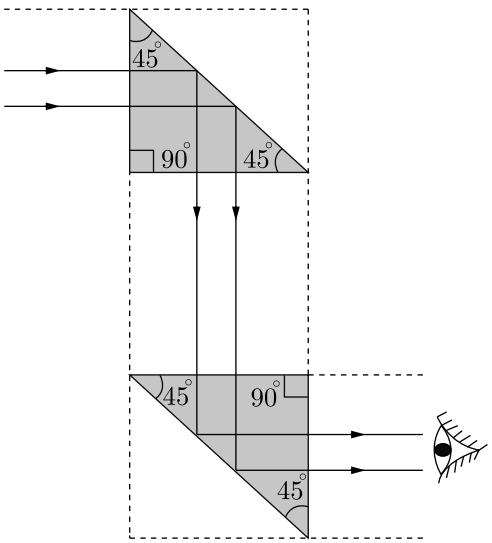
Ans : MAIN 2009

Types of lens	**Position of object**	**Nature of image**	**Size of image**
Convex	At F	Real, inverted	Highly enlarged
Concave	At infinity	Virtual, erect	Highly diminished

259. What is a periscope? Draw a ray diagram using right angled prisms.

Ans : SQP 2000

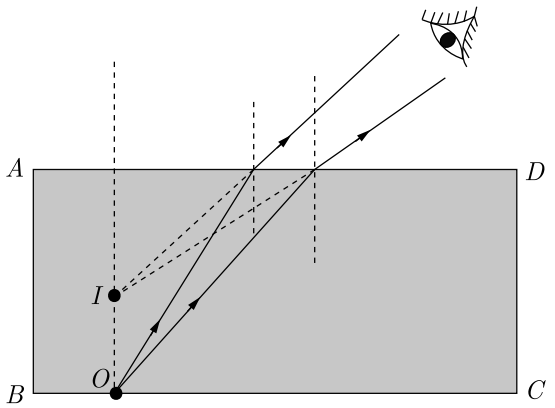
Periscope is an apparatus used to view the objects at a height/depth which are not visible directly. In periscope, if two parallel plane mirrors are used, it works on the principle of reflection or two right angled prisms are placed parallel in place of parallel plane mirrors.



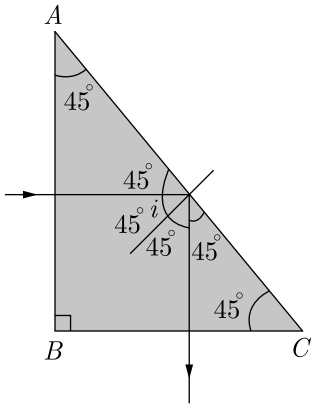
260. If a glass block is placed over a mark on paper, the mark seems to rise. Explain.

Ans : COMP 2016

When a glass block is placed over a mark on a paper, the mark seems to rise due to refraction of light from denser medium to rarer medium at the plane surface separating the two media.



261. A ray of light passes through a right angled prism as shown in the figure. State the angles of incidence at the faces AC and BC.



Ans : SQP 2019

Angle of incidence at face $AC = 45°$
Angle of incidence at face $BC = 0°$

262. What do you mean by absolute refractive index of a medium?

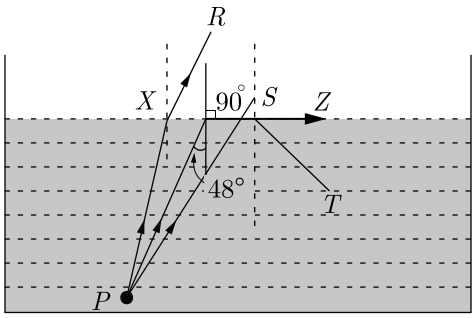
Ans : MAIN 2016

If the refractive index is expressed with respect to vacuum or air, it is called absolute refractive index and denoted by the symbol μ.

$$_1\mu_2 = \frac{\sin i}{\sin r}$$

If the medium 1 is air or vacuum, the constant

NODIA



285. Why does the sky appear dark instead of blue to the passengers at very high altitudes or to an astronaut?

Ans : MAIN 2010

When sunlight passes through the atmosphere, the fine particles in air scatter the blue colour (shorter wavelength) more strongly than red. The scattered blue light enters our eyes. If the earth had no atmosphere there would not have been any scattering and the sky would have looked dark. This is why the sky appears dark to passengers flying at very high altitudes or to an astronaut.

286. During sunset and sunrise, the sun is seen even when it is slightly below the horizon. Explain.

Ans : SQP 2014

When light is coming from the sun towards the earth, it suffers refraction from rarer to denser layers upto the earth. Therefore, it bends towards the normal at successive refractions but to the observer on the earth it appears to be coming from a straight line path above the horizon. So it is seen above the horizon while actually it is below the horizon due to refraction of light through the layers of the atmosphere. Similarly at the time of sunset, it actually sets, i.e. goes down below the horizon but appears above the horizon.

287. State three characteristics of the image of an extended source formed by a concave lens.

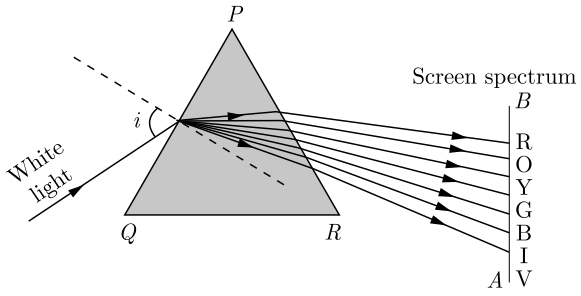
Ans : SQP 2020

The characteristics of the image of an extended source formed by concave lens are :
(i) virtual, (ii) erect and (iii) highly diminished if the object is at infinity (or diminished if the object is between optical centre and infinity)

288. What is spectrum? Show its formation with the help of a neat labelled ray diagram.

Ans : COMP 2019

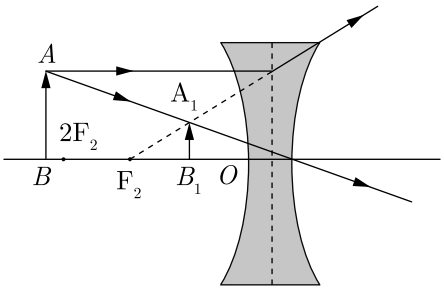
Spectrum is the band of seven colours obtained due to dispersion of white light.



289. A linear object is placed on the axis of a lens. An image is formed by refraction in the lens. For all positions of the object on the axis of the lens, the positions of the image are always between the lens and the object.
(a) Name the lens.
(b) Draw a ray diagram to show the formation of the image of an object placed in front of the lens at any position of your choice except infinity.

Ans : MAIN 2011

(a) Concave lens or diverging lens
(b)



290. The refractive index of glass with respect to air is ${}_a\mu_g$ and of a liquid with respect to air is ${}_a\mu_l$. Express the refractive index of glass with respect to liquid.

Ans : MAIN 2008

We know that, $${}_a\mu_g = \frac{\mu_g}{\mu_a} \quad ...(1)$$

$${}_a\mu_l = \frac{\mu_l}{\mu_a} \quad ...(2)$$

Dividing equations (1) and (2)

$$\frac{{}_a\mu_g}{{}_a\mu_l} = \frac{\mu_g}{\mu_l} = {}_l\mu_g$$

Refractive index of glass with respect to liquid,

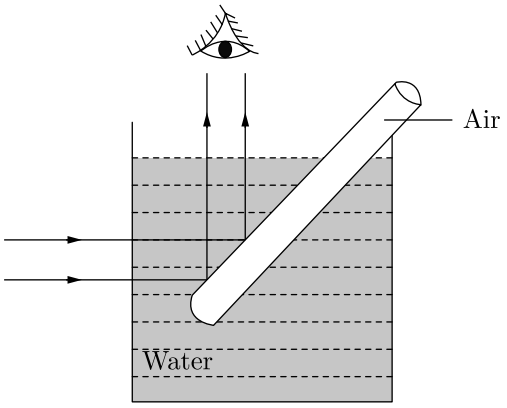
$${}_l\mu_g = \frac{{}_a\mu_g}{{}_a\mu_l}$$

NODIA

291. Why does the surface of an empty test tube (kept in a beaker filled with water) shines like a mirror? Explain.

Ans : COMP 2013

The surface of the test tube separates water (denser medium) from air (rarer medium) in the tube. The incident rays on the surface of tube shows the phenomenon of total internal reflection which makes the surface of an empty test tube shiny like a mirror.

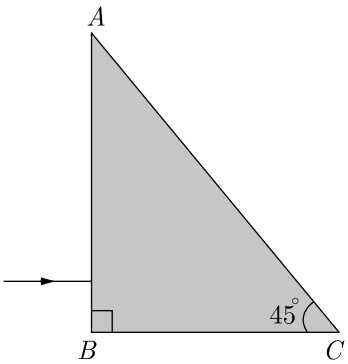


292. How can you account for the brilliance of a diamond?

Ans : SQP 2011

Refractive index of diamond is 2.47 and the critical angle is 24° only. The faces of diamond are cut in such a way that the ray of light entering the diamond suffers repeated total internal reflections (angle of incidence is greater than critical angle) from different faces and finally comes out of it. Thus it sparkles.

293. The diagram given below shows a right-angled prism with a ray of light incident on the side AB . (The critical angle for glass is 42°)

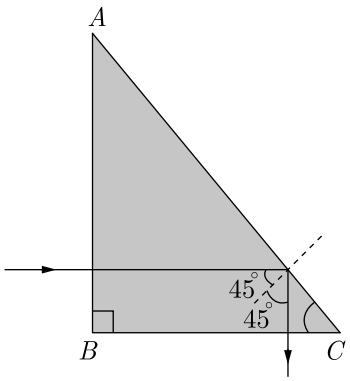


(a) Copy the diagram and complete the path of the ray of light in and out of the glass prism.

(b) What is the value of the angle of deviation shown by the ray?

Ans : COMP 2004

(a)



(b) 90°

294. What two conditions must be fulfilled for total internal reflection of light to occur?

Ans : MAIN 2001

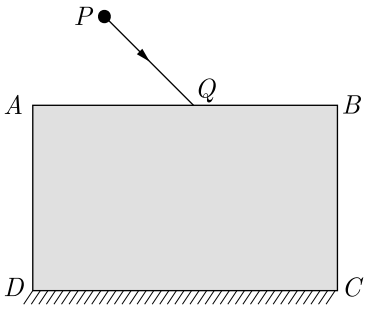
Conditions for total internal reflection:

(i) The ray must strike the interface from denser side.

(ii) Angle of incidence must be greater than the critical angle.

295. (a) The given diagram shows a ray of white light PQ coming from an object P and incident on the surface of a thick glass plane mirror. Copy the diagram and complete it to show the formation of three images of the object P as formed by the mirror.

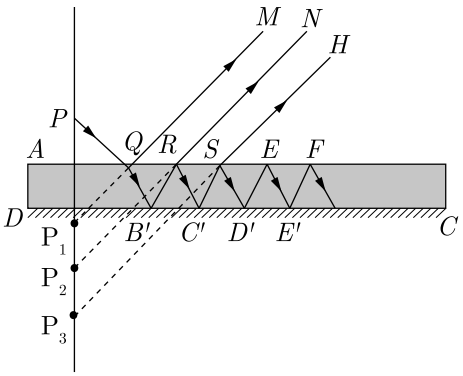
(b) Which image will be the brightest image?



Ans : COMP 2003

(a)

Downloaded from www.pdf.tube



(b) Second image P_2 is the brightest.

296. An object is placed in front of a lens between its optical centre and the focus. The image formed is virtual, erect and diminished.

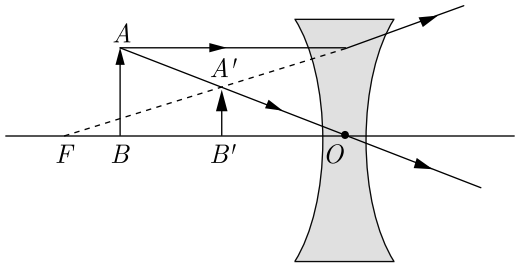
(i) Name the lens which forms this image.

(ii) Draw a ray diagram to show the formation of an image with the above characteristics.

Ans : MAIN 2003

(i) The lens is a concave lens.

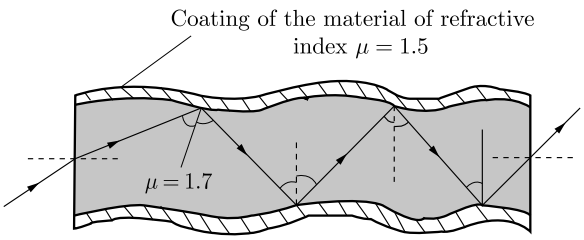
(ii) The ray diagram is as shown below :



297. What do you mean by an optical fibre? Draw a labelled diagram to illustrate its working.

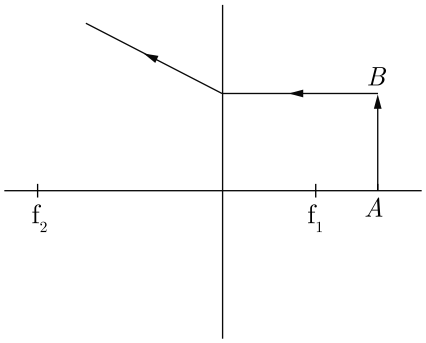
Ans : MAIN 2007

Optical fibre consists of thousands of long fine quality glass of quartz fibre of high refractive index of 1.7. Optical fibres are coated with a thin layer of a material of low refractive index of about 1.5. When light is incident on one end of the fibre at small angle, it suffers total internal reflections along the fibre and comes out at the other end of the bent fibre as shown in the figure.



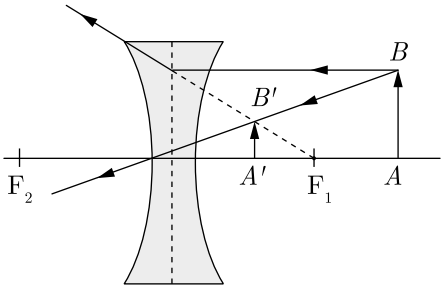
Optical fibre is used in telephone and other signal transmitting cables.

298. Copy the given figure and complete it to show the formation of the image of the object AB. Name the lens used in the figure.

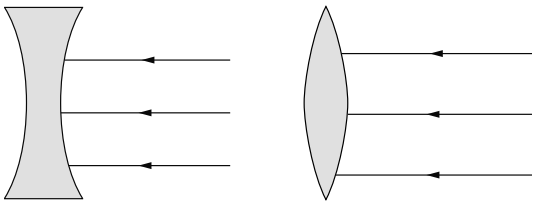


Ans : SQP 2005

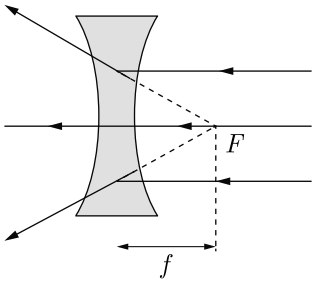
Since the ray of light is diverged, therefore, the lens is a concave lens. The complete figure is as shown below :



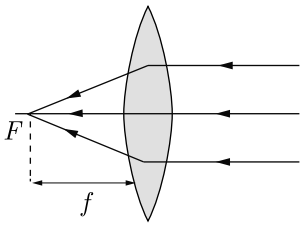
299. Copy and complete the following ray diagrams. In the diagram indicate the focal lengths of the lenses



Ans : SQP 2011



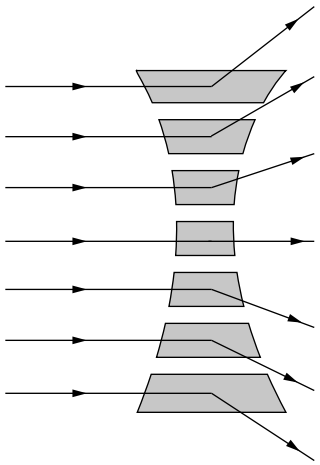
NODIA



300. Draw a diagram to show the divergent action of a diverging lens by treating it as a combination of prisms with the bases away from the centre of the lens.

Ans : COMP 2000

The diagram is as shown below :

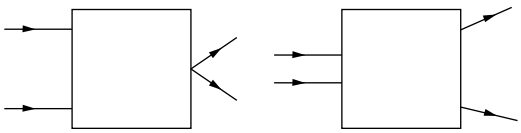


301. What is the difference between a double convex and a bi-convex lens?

Ans : SQP 2001

In both cases, the two surfaces are convex towards air. In case of double convex lens, the two surfaces may have any values for the two radii of curvature of the two surfaces while in bi-convex lens, the radii of curvature of the two surfaces has the same value. Thus, every bi-convex lens is a double convex lens but every double convex may not be bi-convex.

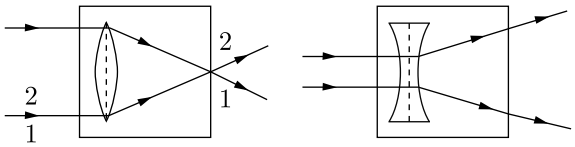
302. Figures 'a' and 'b' are shown below the incident and transmitted rays through lens kept in a box in each case. Draw the lens and complete the path of rays through it.



(a) (b)

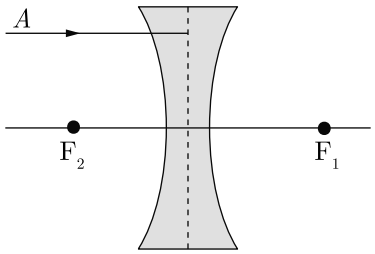
Ans : COMP 2022

The ray diagram is as follows :

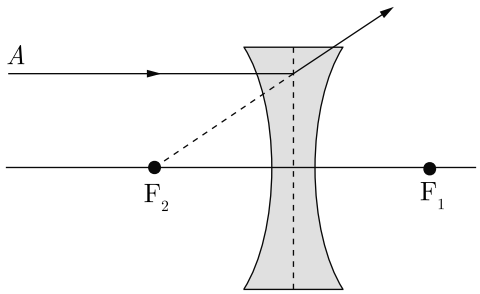


(a) (b)

303. In figure 'a' below of a thin concave lens, F_1 and F_2 are foci. Complete the path of the given ray of light after it emerges out of the lens.



(a)



(b)

Ans : COMP 2023

Figure (b) shows the complete path of rays through the lens.

304. You are provided with a printed piece of paper. Using this paper how will you differentiate between a convex lens and a concave lens?

Ans : SQP 2007

On bringing the two lenses very close to the printed paper, if the letters appear

1. erect and magnified, the lens is a convex lens.
2. erect and diminished, the lens provided is a concave lens.

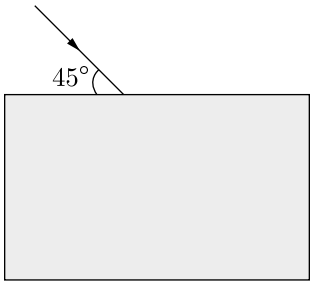
305. A concave mirror and a convex lens are held in water. What changes, if any, do you expect in their focal length ?

Ans : SQP 2017

Click Here to Buy book on Amazon

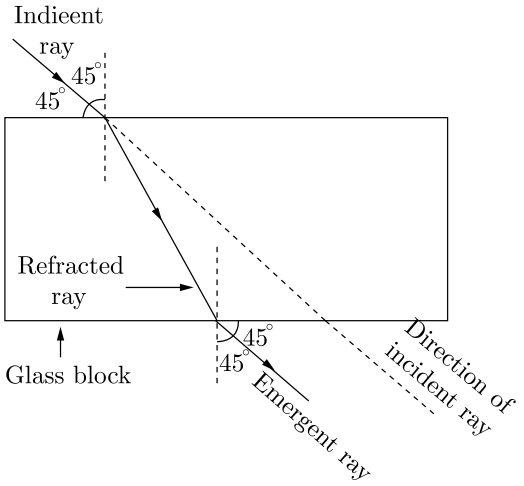
The focal length of a mirror does not depend upon the nature of the medium in which it is placed whereas the focal length of a lens depends upon the medium in which it is placed. Thus, there will be no change in the focal length of the concave mirror whereas the focal length of the convex lens will change.

306. Draw the diagram given below and clearly show the path taken by the emergent ray.

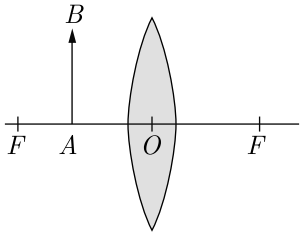


Ans : MAIN 2023

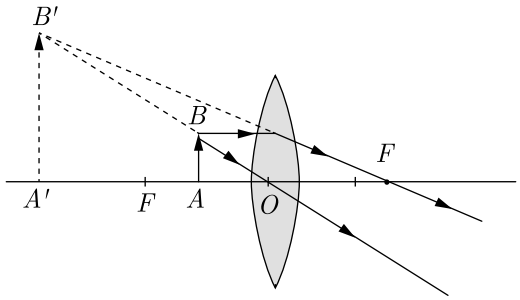
The path of the emergent ray will be parallel to the incidence ray extended. This is according to Snell's law.



307. An object AB is placed in front of a convex lens as shown below. Copy the diagram and complete it to show the refraction of two rays emerging from the point B.
Indicate the position and nature of the image formed.

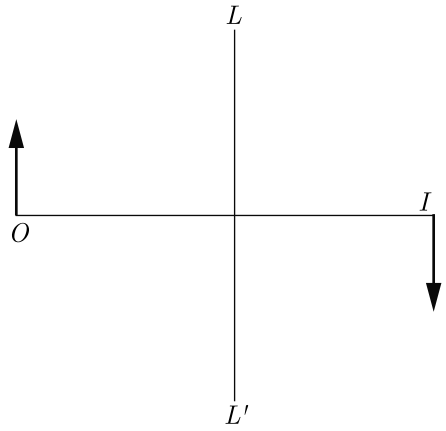


Ans : MAIN 2010



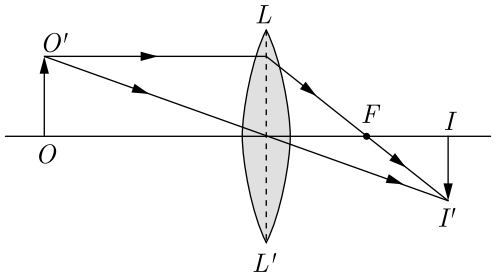
The image is formed on the same side as the object. It is virtual, erect and magnified.

308. The diagram shows the object O and the image I formed by a lens. Copy the diagram and on it mark the position of the lens LL' and focus F. Name the lens.



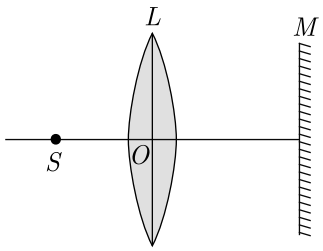
Ans : MAIN 2021

The lens is convex.



309. Figure below shows a point source of light S, a convex lens L and a plane mirror M. The three are placed such that rays of light from S return to it after reflection from M.
(i) What is the distance OS called ?
(ii) To which point (left of S, on S or right of S) will the rays return if M is moved to the left and brought in contact with L?

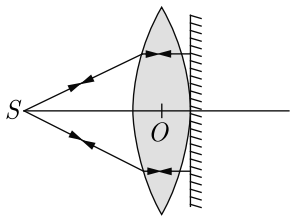
NODIA



Ans : COMP 2016

(i) The distance OS is called the focal length of the lens.

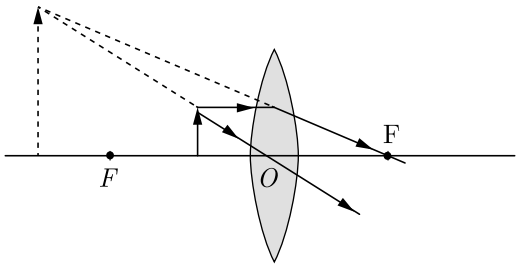
(ii) The rays will still return to the same point S. The ray diagram of the situation is as shown below :



310. Draw a ray diagram to illustrate the formation of an enlarged and upright image of an object by a lens. Name the lens used. Where should the object be placed relative to the lens? Will the image be real or virtual? Name a device where this action of lens is used.

Ans : COMP 2004

The ray diagram is as shown below :

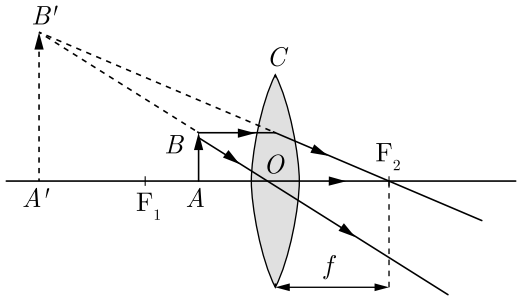


The lens used is a convex lens. The object should be placed between the optical centre and the focus of the lens. The image formed is virtual. This action of the lens is used in a simple microscope or simple magnifier.

311. An object is placed in front of a lens between its optical centre and focus. The image formed is virtual, erect and magnified. Name the lens and draw a ray diagram showing the formation of the image

Ans : MAIN 2000

The lens is convex.



312. A virtual image cannot be focused on a screen. Yet when we see a virtual image, we obviously bring it to the screen that is the retina of our eyes. Is this a contradiction ?

Ans : SQP 2005

No, the lens of the eye converges the divergent beam of light (that produces virtual image) to the retina, thereby forming a real image of the virtual object.

313. A harpoon used to kill a fish is aimed at a point below the apparent position of the fish. Why?

Ans : SQP 2004

A harpoon used to kill a fish is aimed at a point below the apparent position of the fish because the fish appears to be raised up due to refraction of light from denser medium (water) to rarer medium (air) at the surface separating two media.

314. The refractive index of glass with respect to air is ${}_a\mu_g$ and of liquid with respect to air is ${}_a\mu_l$. Express the refractive index of glass with respect to liquid.

Ans : COMP 2009

We know that, $${}_a\mu_g = \frac{\mu_g}{\mu_a} \quad \text{... (1)}$$

$${}_a\mu_l = \frac{\mu_l}{\mu_a} \quad \text{... (2)}$$

Dividing equations (1) and (2), we have

$$\frac{{}_a\mu_g}{{}_a\mu_l} = \frac{\mu_g}{\mu_l} = {}_l\mu_g$$

Refractive index of glass with respect to liquid

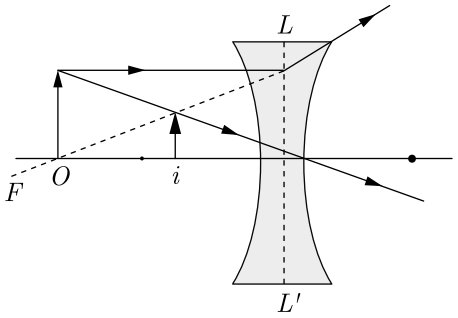
$${}_l\mu_g = \frac{{}_a\mu_g}{{}_a\mu_l}$$

315. The diagram shows an object O, and its image 'I' formed by a lens. In the diagram, draw the lens and the rays to show how the image is formed. Mark focus F, of the lens. Name the lens.

Downloaded from www.pdf.tube

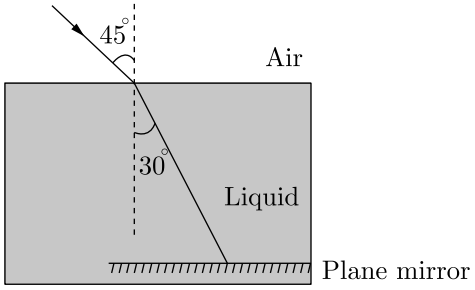
Ans : MAIN 2017

The complete diagram is as follows :



The lens is concave. Since the image is smaller than the object.

316. A ray of monochromatic light enters a liquid from air as shown in the diagram given below.

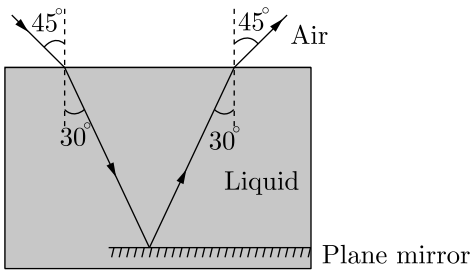


(i) Copy the diagram and show in the diagram the path of the ray of light after it strikes the mirror and re-enters the medium of air.

(ii) Mark in your diagram the two angles on the surface of separation when the ray of light moves out from the liquid to air.

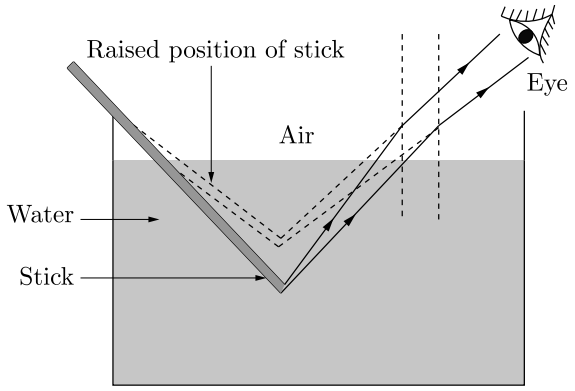
Ans : SQP 2011

(i) and (ii)



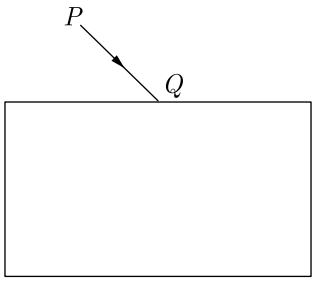
317. A stick partly immersed in water appears to be bent. Draw a ray diagram to show the bending of the stick when placed in water and viewed obliquely from above.

Ans : COMP 2010



NODIA

318. In the diagram given below, PQ is a ray of light incident on a rectangular glass block.

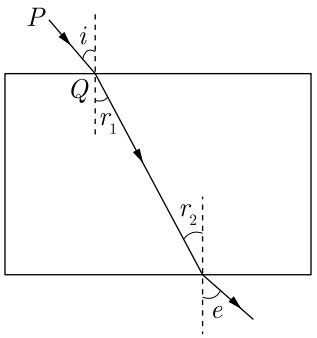


(i) Copy the diagram and complete the path of the ray of light through the glass block. In your diagram, mark the angle of incidence by letter i and the angle of emergence by the letter e.

(ii) How are the angles i and e related to each other?

Ans :

(i)



(ii) $\angle i = \angle e$

THREE MARKS QUESTIONS

319. The diagram below shows a fish in the tank and its image seen in the surface of water.

(a) Name the phenomenon responsible for the formation of this image.

(b) A double convex lens with refractive index μ_1 inside two liquids of refractive indices μ_2 and μ_3 are shown in the diagrams below. The refractive indices are such that $\mu_2 > \mu_1$ and $\mu_1 > \mu_3$.

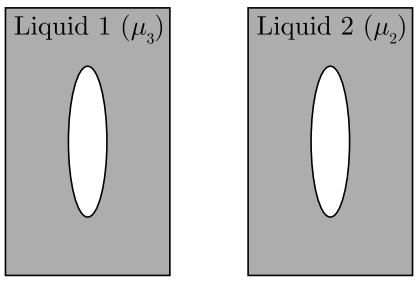


Figure (a) Figure (b)

How would a parallel incident beam of light refract when it comes out of the lens in each of the cases shown above?

(1) in Figure a.

(2) in Figure b.

Ans : SQP 2025

(a) Total internal reflection.

(b) 1. Converge
2. Diverge

320. The refractive index of water is 1.33 at a certain temperature. When the temperature of water is increased by 40 °C, the refractive index changes to 'x'.

(a) State whether $x < 1.33$ or $x > 1.33$.

(b) State two differences between normal reflection and total internal reflection.

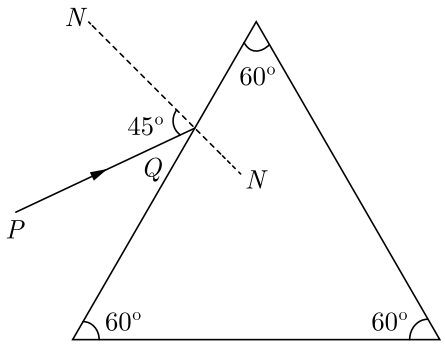
Ans : SQP 2025

(a) $x < 1.33$

(b)

Reflection	TIR
Takes place in any medium, denser or rarer	Takes place only in a denser medium
Takes plase for any angle of incidence.	Takes place only when the angle of incidence is greater than critical angle.

321. A monochromatic ray of light is incident on an equilateral prism placed at minimum deviation position with an angle of incidence 45° as shown in the diagram.

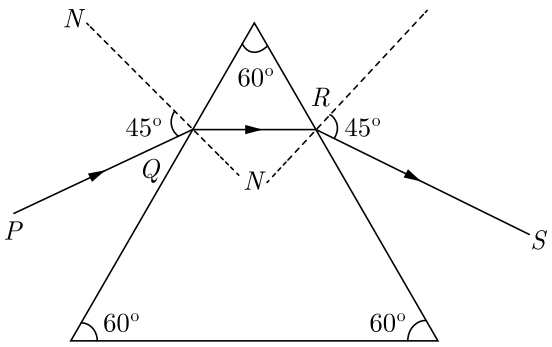


(a) Copy the diagram and complete the path of the ray PQ.

(b) State two factors on which the angle of deviation depends.

Ans : MAIN 2024

(a)



(b) Angle of deviation depends on
1. Angle of incidence
2. Refractive index

322. (a) Refractive index of glass with respect to water is $\frac{9}{5}$. Find the refractive index of water with respect to glass.

(b) Name the principle used to find the value in

Click Here to Buy book on Amazon

part (a).

(c) If we change the temperature of water, then will the ratio $\frac{9}{8}$ remain the same? Write Yes or No.

Ans : MAIN 2024

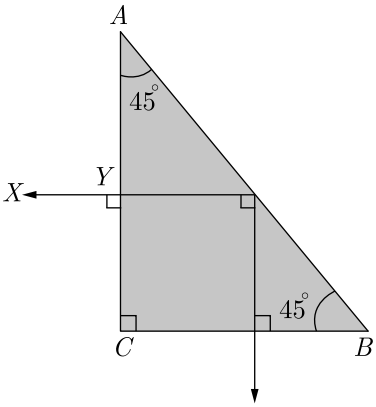
(a) Refractive index of glass with respect to water $= \frac{9}{8}$

Hence, the Refractive index of water with respect to glass $= \frac{8}{9}$

(b) The principle of reversibility

(c) No.

323. A ray of light XY passes through a right-angled isosceles prism as shown below



(i) What is the angle through which the incident ray deviates and emerges out of the prism?

(ii) Name the instrument where this action of prism is put into use.

(iii) Which prism surface will behave as a mirror?

Ans :

(i) 90°; (ii) Periscope; (iii) AB

324. Light travels a distance of '$10x$' units in time 't_1' in vacuum and it travels a distance of 'x' units in time 't_2' in a denser medium. Using this information answer the question that follows:

(a) 'Light covers a distance of '$20x$' units in time 't_1' in diamond. 'State true or false.

(b) Calculate the refractive index of the medium in terms of 't_1' and 't_2'.

Ans : MAIN 2024

(a) The statement is false.
Diamond is a denser medium compared to vacuum. Hence, in it light cannot cover longer distance than that in vacuum.

(b) Speed of light in vacuum $= \frac{10x}{t_1}$

Speed of light in the medium $= \frac{x}{t_2}$

So, refractive index of the medium

$$= \frac{\frac{10x}{t_1}}{\frac{x}{t_2}} = \frac{10t_2}{t_1}$$

$= 3.4$ m

325. (a) Write a relationship between angle of incidence and angle of refraction for a given pair of media.

(b) When a ray of light enters from one medium to another having different optical densities it bends. Why does this phenomenon occur?

(c) Write one condition where it does not bend when entering a medium of different optical density.

Ans : COMP 2016

(a) For a given pair of media, the ratio of the sine of angle of incidence to the sine of the angle of refraction is a constant, called the refractive index of second medium with respect to the first.

i.e. $\frac{\sin i}{\sin r} = \mu$

(b) The refraction of light occurs because light travels with different speeds in different media.

(c) The ray of light which is incident normally on the surface separating the two media passes without bending i.e. for angle of incidence $\angle i = 0$ the angle of refraction $\angle r = 0°$.

326. Jatin puts a pencil into a glass container having water and is surprised to see the pencil in a different state.

(i) What change is observed in the appearance of the pencil ?

(ii) Name the phenomenon responsible for the change.

(iii) Draw a ray diagram showing how the eye sees the pencil.

Ans : MAIN 2015

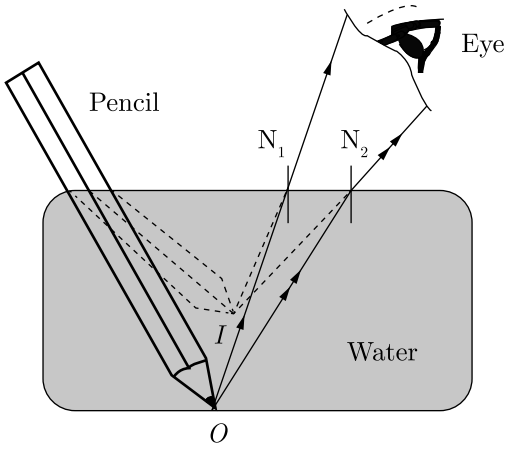
(i) The pencil seems bent at the water-air interface.

(ii) Refraction of light.

(iii) The ray diagram is as shown :

Download NODIA App for All Sample Papers PDFs

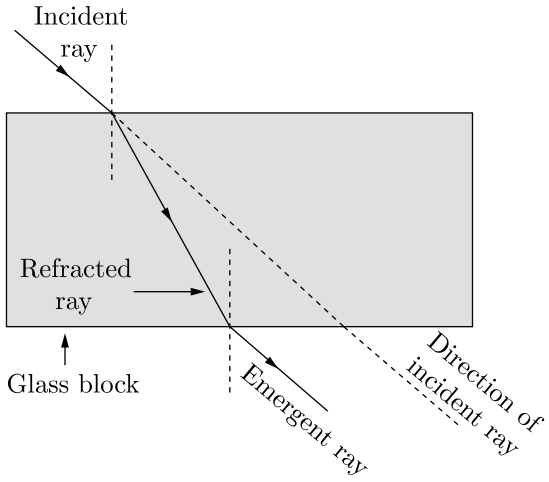
Downloaded from www.pdf.tube

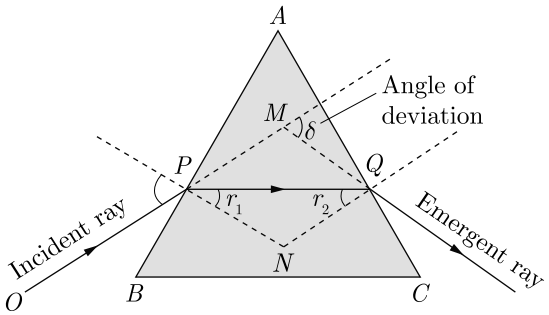


327. Light passes through a rectangular glass slab and through a triangular glass prism. In what way does the direction of the two emergent beams differ and why ?

Ans : SQP 2014

In case of a rectangular glass slab, emergent rays of light are always parallel to the direction of incident rays.

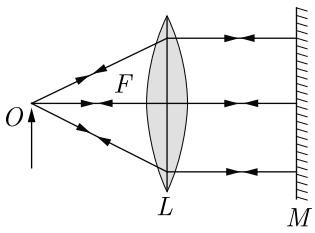




When a light ray passes through a prism, it bends towards the base of the prism. Hence, incident ray and emergent ray are not parallel to each other as they are in case of a glass slab.

328. The ray diagram given below illustrates the experimental set up for the determination of the focal length of a converging lens using a plane mirror.

(i) State the magnification of the image formed.
(ii) Write two characteristics of the image formed.
(iii) What is the name given to the distance between the object and optical centre of the lens in the given diagram ?



Ans : MAIN 2005

(i) The magnification of the image formed is unity (or 1).
(ii) The image formed is (1) real and (2) inverted, is at the same position as the object.
(iii) The distance, between the object and the optical centre of the lens, is called the focal length of the lens.

329. What do you mean by absolute refractive index of a medium ?

Ans : COMP 2010

If the refractive index is expressed with respect to vacuum or air, it is called absolute refractive index and denoted by the symbol μ.

$$_1\mu_2 = \frac{\sin i}{\sin r}$$

If the medium 1 is air or vacuum, the constant ratio given by equation is called absolute refractive index of medium 2. Absolute refractive index can also be defined in terms of speed of light, i.e., the ratio of speed of light in vacuum to the speed of light in the medium is called the refractive index of the medium.

$$\mu = \frac{\text{Speed of light in vacuum of air}}{\text{Speed of light in the medium}}$$

330. Draw a ray diagram to illustrate the determination of the focal length of a convex lens using an auxiliary plane mirror.

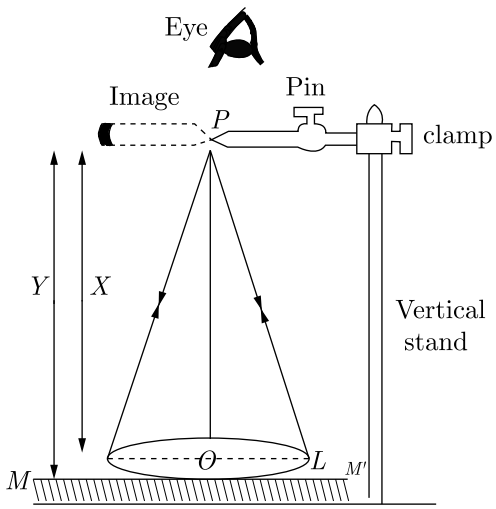
Ans : COMP 2008

On placing lens L on a plane mirror MM′, the pin P is clamped so that its tip is vertically above the centre O of the lens L, then height of the pin is

NODIA

adjusted to remove parallax and distance x of the pin from the lens is measured and the distance y of the pin from mirror is measured. The average of the two distances gives the focal length of the lens.

Hence, $$f = \frac{x+y}{2}$$



331. (a) If a monochromatic beam of light undergoes minimum deviation through an equiangular prism, how does the beam pass through the prism, with respect to its base?

(b) If white light is used in the same way as in (*i*) above, what change is expected in the emergent beam?

Ans : SQP 2014

(a) In the position of minimum deviation through an equiangular prism, the angle of incidence is equal to angle of emergence (i.e., $i = e$) hence the refracted beam passes parallel to the base of the prism.

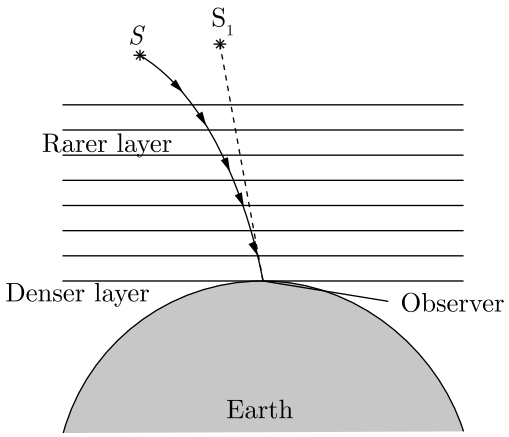
(b) If white light is used in the same way as in (*i*) above, dispersion of light takes place. We know that the angle of deviation depends on the wavelength of light. The refractive index of a given transparent material decreases with the increase in the wavelength of the light (i.e., as $\lambda_r > \lambda_v$, $\mu_v > \mu_r$) consequently the given prism deviates the violet light more than the red light (i.e., $\delta_v > \delta_r$).

332. Why do the stars show the twinkling effect whereas the planets do not?

Ans : MAIN 2016

The light from star suffers a series of refraction due to atmospheric layers of different densities and different refractive indices. Due to this reason, a ray of light starting from a star S bends more and more towards the normal before reaching the observer on the earth. But the observer sees the star in the direction of the ray reaching finally in the eye, so star appears to him at S_1 instead of S. On account of change in temperature and density the apparent position of the star continuously changes which gives the twinkling effect to the star.

But the planets do not twinkle because they are nearer to the earth and subtend a greater angle at the amount of light received from them is much larger than the stars. Therefore, the change in their position and brightness is not noticeable.



333. Give one use each of the electromagnetic radiations given below:

(a) Microwaves

(b) Ultraviolet radiations

(c) Infrared radiations.

Ans : SQP 2007

(a) Microwaves are used for cooking in ovens.

(b) Ultraviolet radiations are used for detection of invisible writing.

(c) Infrared radiations are used to detect the secret writings on the walls.

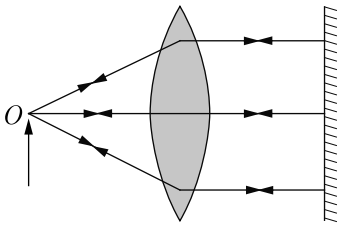
334. The given ray diagram below illustrates the experimental set up for the determination of the focal length of a converging lens using a plane mirror.

(a) State the magnification of the image formed.

(b) Write two characteristics of the image formed.

(c) What is the name given to the distance between the object and optical centre of the lens in the above diagram?

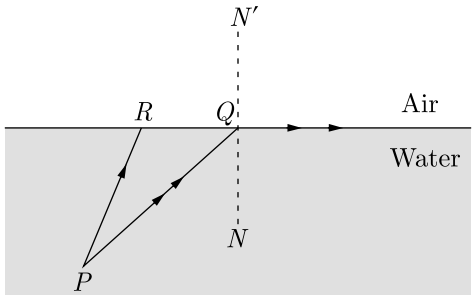
Click Here to Buy book on Amazon



Ans : COMP 2018

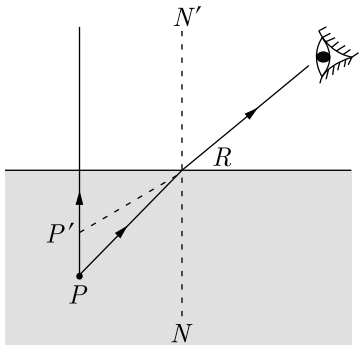
(a) $m = 1$, as distance of image from lens is same as that of object.
(b) Real and inverted.
(c) Focal length.

335. PQ and PR are two light rays emerging from the object P as shown in the figure below:



(a) What is the special name given to the angle of incidence ($\angle PQN$) of ray PQ?
(b) Copy the ray diagram and complete it to show the position of the image of the object P when seen obliquely from above.
(c) Name the phenomenon that occurs if the angle of incidence $\angle PQN$ is increased still further.

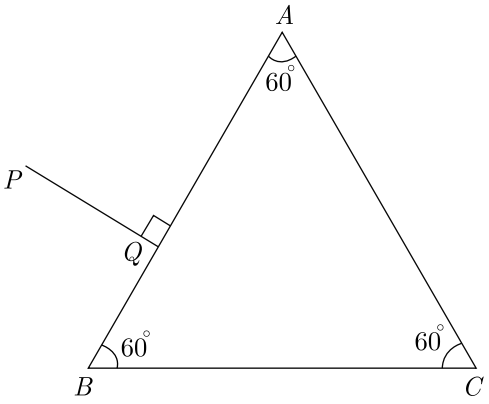
Ans : MAIN 2003



(a) Critical angle.
(b) Image of the object P will be formed at P' when seen obliquely from above.
(c) Total internal reflection.

NODIA

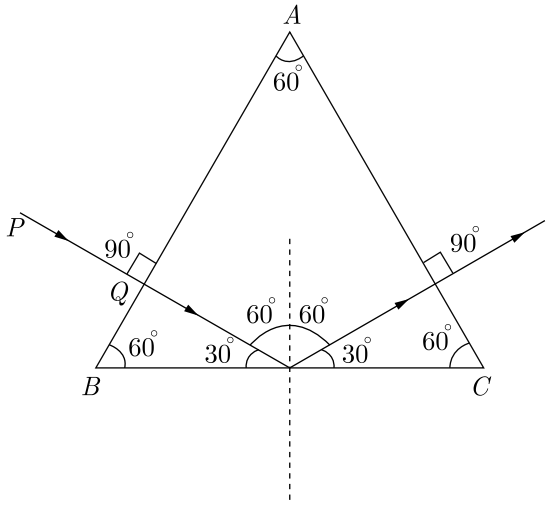
336. (a) Copy the diagram given below and complete the path of light ray till it emerges out of the prism. The critical angle of glass is 42°. In your diagram mark the angles wherever necessary.



(b) State the dependence of angle of deviation:
(i) On the refractive index of the material of the prism.
(ii) On the wavelength of light.

Ans : COMP 2014

(a)



(b) (i) If the refractive index of material of the prism decreases, the angle of deviation decreases.
(ii) The angle of deviation decreases with the increase in wavelength. The angle of deviation for violet colour is more than the angle of deviation for red colour.

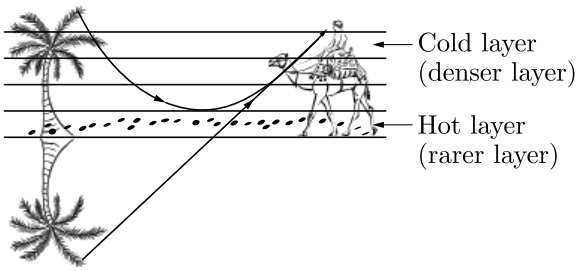
337. What do you mean by phenomenon of mirage? Explain it briefly with the help of a ray diagram.

Ans : MAIN 2002

Mirage is an optical illusion caused due to total internal reflection of light in sandy deserts or in some extended surface like a black tarred road in very hot weather.

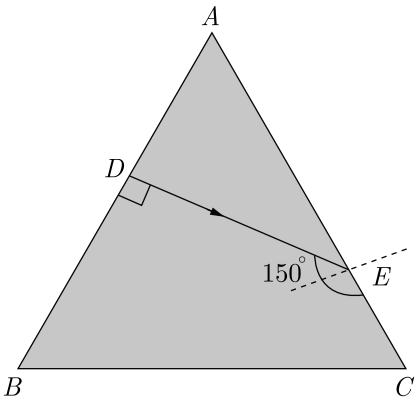
In hot summer days sandy land becomes very hot during the day time. The air in contact with the ground becomes hot and its density is reduced whereas the density of air at higher level remains unaffected. Therefore, the layers of air near the ground are warmer than the air at the upper level. Thus, the successive upper layers are denser than those below them.

When the ray of light from the top of a tree travels from a denser to a rarer layer, it bends away from a normal and thereby at a stage the angle of incidence becomes greater than the critical angle, the rays suffer total internal reflection and reach the eyes of the observer. Observer sees an inverted image of the tree and concludes that there is water near the tree. Thus it gives an optical illusion.



Mirage

338. The critical angle for the glass of which the equilateral prism ABC is made is 60°. A ray of light incident on the side AB of the prism is refracted along DE such that the angle it makes with the side AC is 150°. Also, $\angle EDB = 90^\circ$. Copy the diagram.

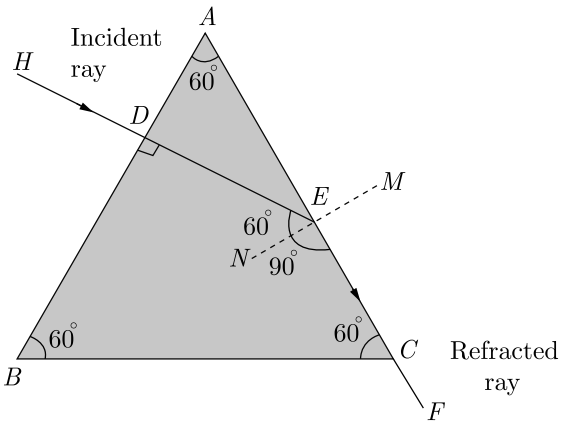


(a) Draw the path of the ray incident on the side AB. (which travels along DE.)

(b) Show the path along which the ray DE travels from the point E onwards and through the side BC.

Ans : SQP 2021

(a) Since the ray DE through prism is normal to AB, i.e. $\angle r = 0^\circ$, hence angle i which HD makes with normal to AB before striking face $AB = 0^\circ$.



(b) Since angle,

$$\angle DEN = \angle DEC - \angle NEC$$

$$\angle DEN = 150^\circ - 90^\circ = 60^\circ$$

Which is equal to critical angle. Hence angle of refraction NEC must be 90°, i.e. the ray will go towards ECF.

339. What do you mean by dispersion of light? Explain its cause.

Ans : COMP 2014

Dispersion is the phenomenon of splitting of white light into its constituent colours.

Cause of dispersion : When white light is incident on the face of a prism, the waves of different colours deviate through different angles ($\delta_v > \delta_r$) and in this process get dispersed. On the second surface of the prism, light only suffers refraction. Thus the light further separates out and forms a band of colours known as spectrum.

As we know from the definition of refractive index

$$\mu = \frac{\text{speed of light in air or vacuum}}{\text{speed of light in medium}}$$

The speed of light is different for different colours in a medium, i.e., $v_r > v_v$ where v_v and v_r are the speed of violet and red colour respectively. Therefore, refractive index for violet colour is greater than red, i.e. $\mu_v > \mu_r$.

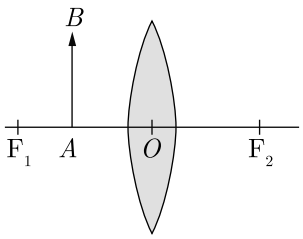
But, $$\mu = \frac{\sin i}{\sin r}$$

$$\sin r = \frac{\sin i}{\mu}$$

Downloaded from www.pdf.tube

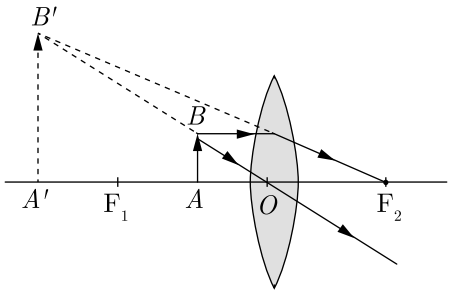
(ii) Now, draw a line AC parallel to principal axis. Join B to C and produce it on the other side of the lens. The point where it meets the principal axis is the second focal point F_2. Measure the distance PF_2 which comes out to be 8 cm. Thus, focal length of the lens is 8 cm.

357. Figure below shows an object AB placed on the principal axis of a convex lens placed in air. F_1 and F_2 are the two foci of the lens. Copy the diagram :
(i) Draw a ray of light starting from B and passing through O. Show the same ray after refraction by the lens.
(ii) Draw another ray from B which passes through F_2 after refraction by the lens.
(iii) Locate the final image formed.
(iv) Is the image real or inverted ?



Ans : COMP 2016

The image formed is virtual and erect. The ray diagram is as shown below :

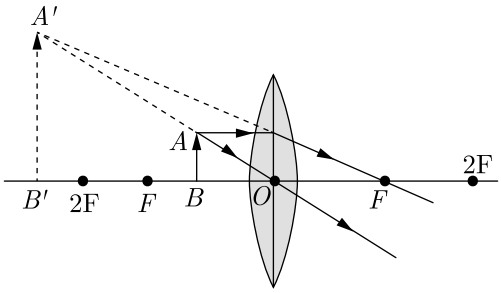


358. An erect, magnified and virtual image is formed, when an object is placed between the optical centre and principal focus of a lens.
(i) Name the lens.
(ii) Draw a ray diagram to show the formation of the image with the above stated characteristics.

Ans : COMP 2018

A virtual, erect and magnified image of an object placed between the optical centre and principal focus a lens. The lens must be convex.

(i) Convex lens.
(ii) The ray diagram is as shown below :



359. How will you decide whether a given piece of glass is a convex lens, concave lens or a plane glass plate?

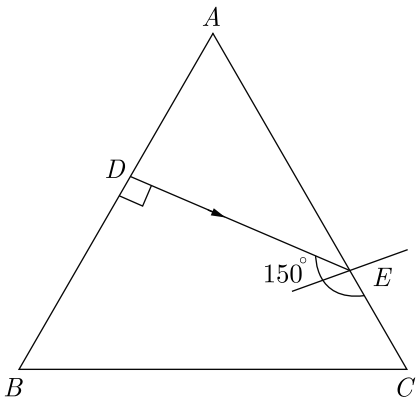
Ans : COMP 2004

Hold the given piece of glass over some printed matter.
(i) If the letters appear magnified, the given piece is a convex lens.
(ii) If the letters appear diminished, the given piece is a concave lens.
(iii) If the letters appear to be of the same size, then it is a plane glass piece.

360. The critical angle for glass of which the equiangular prism ABC is made, is 60°. A ray of light incident on the side AB of the prism is refracted along DE such that the angle it makes with the side AC is 150°. Also, $EDB = 90°$. Draw the path of the incident ray on the side AB (which travels along DE) and also the path which the ray DE travels from the point E onwards.

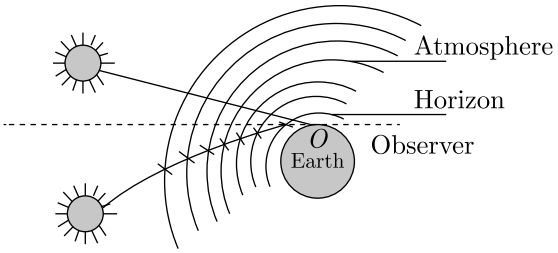
Ans : MAIN 2002

The completed diagram is shown in the figure:



Since the refracted ray DE is normal to the surface AB of the prism, so the incident ray at the point D should also be normal to the surface

NODIA

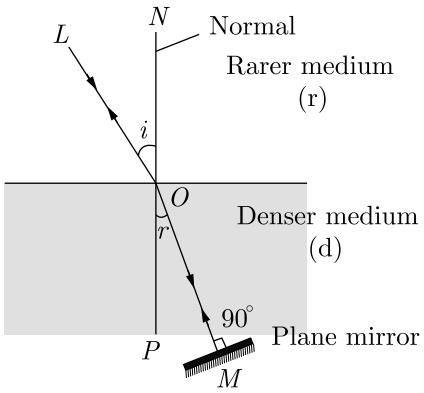


Actual Position of the sun

343. What do you mean by reversibility of light?

Ans : COMP 2020

According to the principle of reversibility of light, the final path of a ray of light after suffering a number of reflections and refractions is reversed, i.e. retraces the same path in the opposite direction as shown in the diagram.



The refractive index of denser medium (d) with respect to rarer medium (r)

$$_r\mu_d = \frac{\sin i}{\sin r} \qquad ...(1)$$

The refracted ray when strikes on mirror, so it reflects back through the same path and refraction takes place in which MO is the incident ray in denser medium (d) and OL is the refracted ray in the rarer medium (r). Now the refractive index of rarer medium (r) with respect to denser medium (d) is

$$_d\mu_r = \frac{\sin i}{\sin r} \qquad ...(2)$$

Multiplying equations (1) and (2)

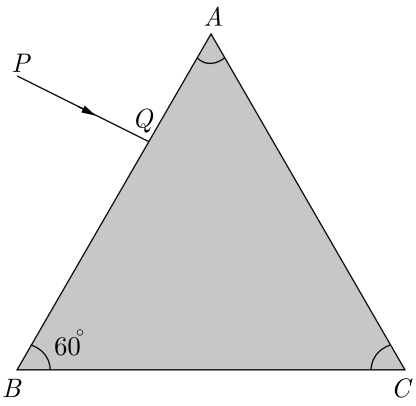
$$_r\mu_d \times {}_d\mu_r = \frac{\sin i}{\sin r} \times \frac{\sin r}{\sin i}$$

$$_r\mu_d \times {}_d\mu_r = 1$$

$$_r\mu_d = \frac{1}{{}_d\mu_r}$$

$$_d\mu_r = \frac{1}{{}_r\mu_d}$$

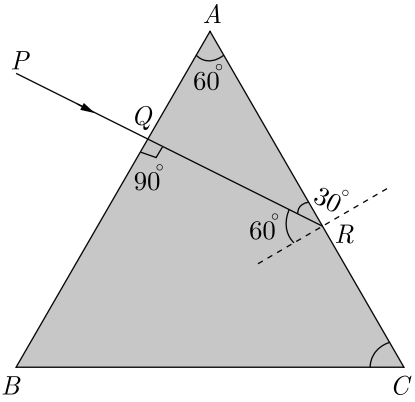
344. (a) In the diagram shown below, a ray of light PQ is incident normally on one face AB of an equilateral glass prism. What are the angles of incidence at the faces AB and AC ?



(b) Complete the ray diagram showing its emergence into air after passing through the prism.

Ans : SQP 2005

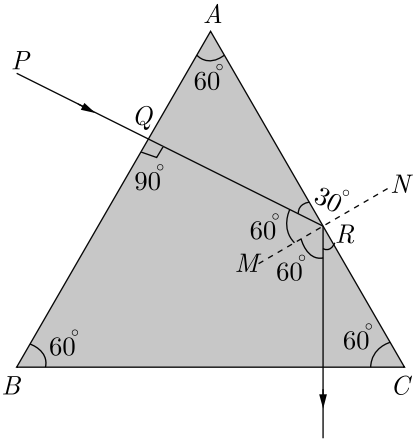
(a)



Angle of incidence at face $AB = 0°$

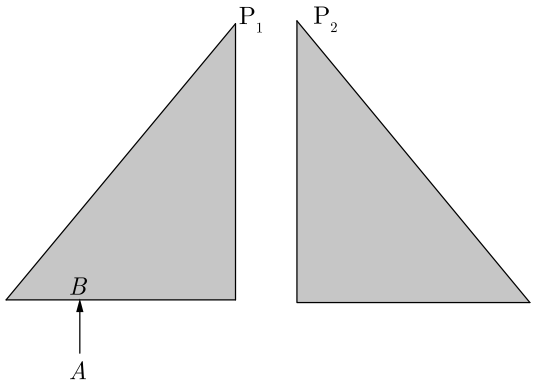
Angle of emergence at face $AC = 60°$

(b)



Click Here to Buy book on Amazon

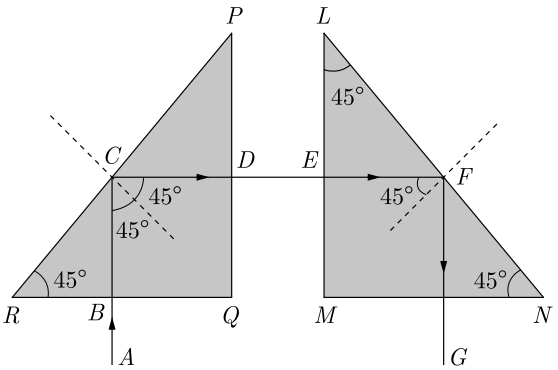
345. (a) Two isosceles right angled prisms are arranged as shown in the figure. Copy the diagram and complete the path of the ray AB along which it passes through the prisms and comes out.



(b) Name the phenomenon being displayed by the path of the ray in the above diagram.

Ans : COMP 2010

(a) The ray AB enters the prism normally and strikes its surface at C making an angle of incidence equal to 45°, being greater than 42°, which is the critical angle for glass-air medium and the ray suffers total internal reflection and strikes the surface PQ normally at point D. It goes out and again strikes the surface LM of the other prism normally. It strikes the surface LN making again an angle of incidence equal to 45°, greater than the critical angle (42°) for glass-air medium and goes out in air along the path FG, making angle of reflection 45°.



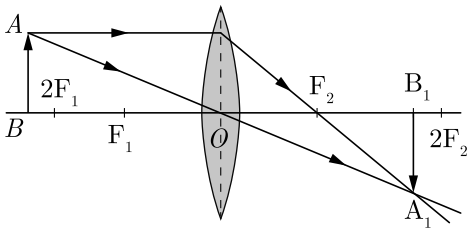
(b) The phenomenon of total internal reflection takes place in both the prisms.

346. (a) An object is placed in front of a converging lens at a distance greater than twice the focal length of the lens. Draw a ray diagram to show the formation of the image.

(b) Mention one difference between reflection of light from a plane mirror and total internal reflection of light from a prism.

Ans : MAIN 2009

(a)



(b)

	Total internal reflection of light from a prism	**Reflection of light from a plane mirror**
(i)	Total internal reflection takes place only when a ray of light travels from a denser medium to rarer medium with the angle of incidence greater than critical angle.	In plane mirror reflection takes place for all angles of incidence.
(ii)	Reflection is total with no refraction into the second medium.	Reflection from a plane mirror is only partial
(iii)	The image is very bright almost as bright as the object.	The image formed is much less bright compared to the object.

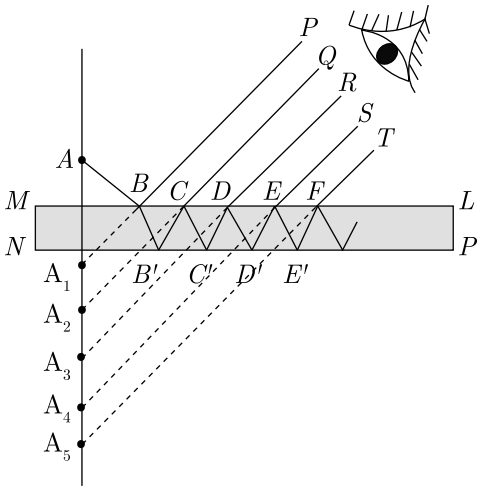
NODIA

347. When a lighted candle is held in front of a thick plane glass mirror, several images can be seen, but the second image is the brightest. Explain.

Ans : COMP 2000

If candle flame is placed in front of a thick mirror and is viewed obliquely, a number of images are seen. Out of these images, the second image is the brightest while others are of diminishing brightness. When a ray of light AB falls on the surface LM of the mirror, a small part of light is reflected in the direction BP, forming a faint image at A, while a larger part of light is refracted along BB' inside the glass and then reflects strongly as $B'C$ and then gets refracted

along CQ in air and forms a virtual image A_2 which is the brightest N image because it is due to light suffering a strong reflection. The reflected ray further keeps on forming multiple images of gradually decreasing brightness.

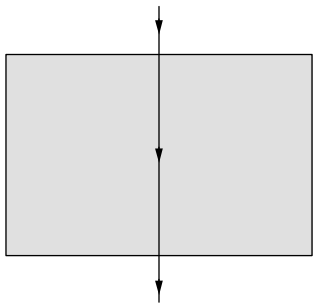


348. (a) A ray of light strikes the surface of a rectangular glass block such that the angle of incidence is (i) 0°, (ii) 42°. Sketch a diagram to show the approximate path taken by the ray in each case as it passes through the glass block and emerges from it.

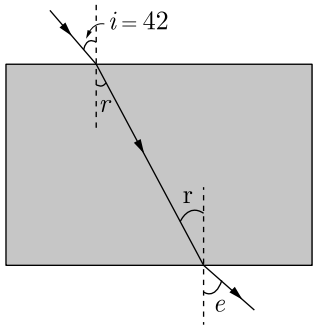
(b) State the conditions required for total internal reflection of light to take place.

Ans : COMP 2011

(a) (i) $\angle i = 0^\circ$



(ii) $\angle i = 42^\circ$



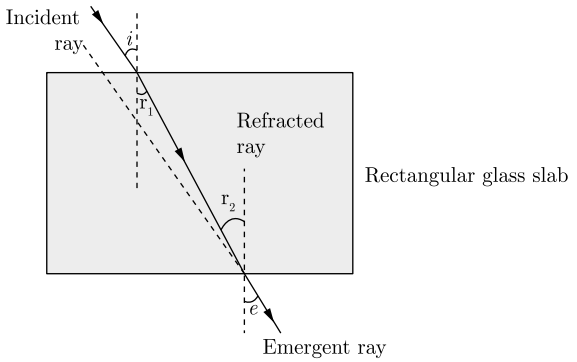
(b) Essential conditions required for total internal reflection of light to take place :

(i) Incident ray must travel from optically denser medium to optically rarer medium.

(ii) The angle of incidence at the surface of separation between the two media must be greater than the critical angle for this pair of media.

349. Draw a ray diagram to illustrate how a ray of light incident obliquely on one face of a rectangular glass slab of uniform thickness emerges parallel to its original direction. Mention which pairs of angles are equal.

Ans : SQP 2023

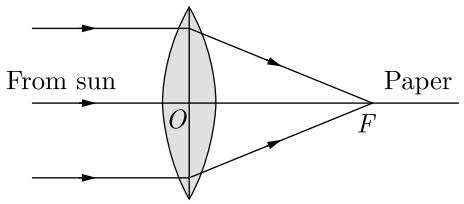


Incident ray and emergent ray are parallel. Angle of incidence (i) and angle of emergence (e) are equal.

350. Can one burn a piece of paper in day light by just using a convex lens instead of a matchstick or any direct flame ? Support your answer with the help of an appropriate ray diagram.

Ans : SQP 2011

We know that a convex lens brings a beam of parallel incident rays to a focus at its focal point. The rays of the sun (practically an infinite distance source) form a parallel incident beam.



When they are allowed to fall on a convex lens, they get focussed at its focal point. If a piece of paper is kept at this focal point, all the (large) heat energy of this parallel beam gets concentrated

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!

Therefore, the angle of refraction (r) for red colour is maximum and for violet colour is minimum, i.e. ($r_r > r_v$). So we can say that due to difference in deviations of different colours (wavelengths) on account of difference in their speeds and refractive indices, phenomenon of dispersion takes place. Therefore, the violet is deviated most and the red is deviated least.

340. State the laws of refraction of light.Write a relation between the angle of incidence (i), angle of emergence (e), angle of prism (A) and angle of deviation (δ) for a ray of light passing through an equilateral prism.

Ans : COMP 2003

(a) The law of refraction are as follows :
   (i) The incident ray, the refracted ray and the normal at the point of incidence, all lie at the same plane.
   (ii) The ratio of sine of the angle of incidence to the sine of the angle of refraction is a constant for a pair of media. This constant is known as the refractive index of the second medium with respect to the first.

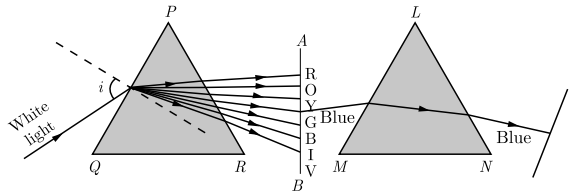
(b) For a ray of light passing through an equilateral prism

$$\angle i + \angle e = \angle A + \angle \delta$$

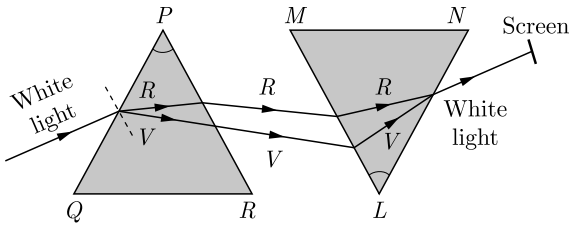
341. Describe the experiment by which composite character of white light was demonstrated by Newton.

Ans : MAIN 2020

Newton performed the following experiments to show the composite character of white light.
He passed the light of any one colour (blue) of the spectrum through another prism and found that on the screen blue colour is observed which proves that the prism by itself produces no colours. It is the white light which consists of seven colours and the prism simply separates them which can be recombined by placing another prism with its base upwards in the path of the dispersed light as shown in the figures.



Analysis of white light



Re-composition of white light

342. Water in a pond appears to be only three quarters of its actual depth.
(a) What property of light is responsible for this observation?
(b) Illustrate your answer with the help of a ray diagram.

Ans : SQP 2005

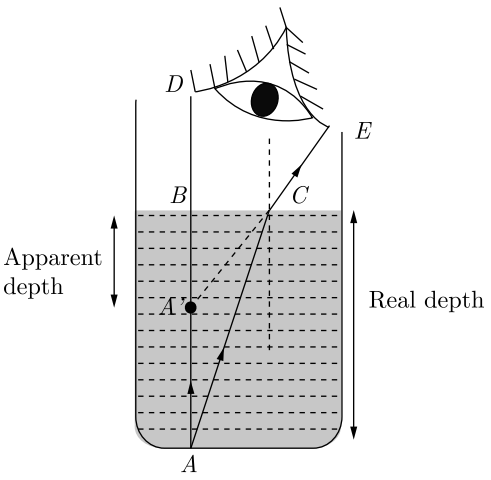
(a) The pond appears to be three quarters of its actual depth due to the property of refraction of light.

$$\text{Refractive index } \mu = \frac{\text{Real depth}}{\text{Apparent depth}}$$

$$\text{Apparent depth} = \frac{3}{4}\ (\text{Real depth})$$

$$\left[\mu = \frac{4}{3}\ \text{water}\right]$$

(b) A ray from bottom of the tank A on striking normally at B goes straight. Another ray from A striking the interface at C is refracted towards CE and when produced back, it appears to come from A'. When BD and CE enter the eye, these form image of A at A'. Thus, the depth appears to be $A'B$ instead of the actual AB.



FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

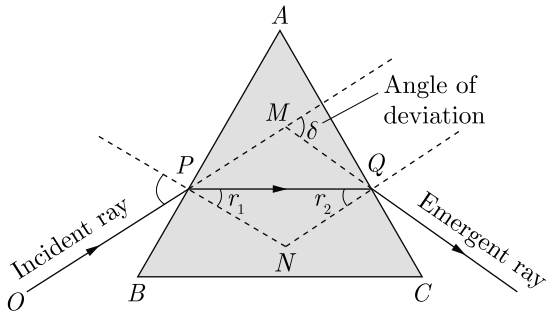
Downloaded from www.pdf.tube

incidence and the angle of emergence when the ray suffers minimum deviation.

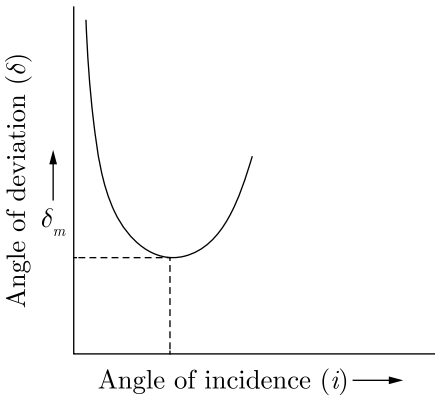
Ans : SQP 2015

In figure (a), a monochromatic ray of light, while passing through a glass prism, deviates through an angle 'δ'. It is found experimentally that with the increase in the value of the angle of incidence there is corresponding decrease in the angle of deviation. If a graph is drawn 'i' against 'δ' as show in figure (b), it is found that for a particular value of the angle of incidence 'i' the angle of deviation 'δ' becomes minimum.

(i)



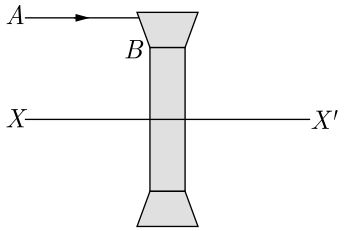
(a)



(b)

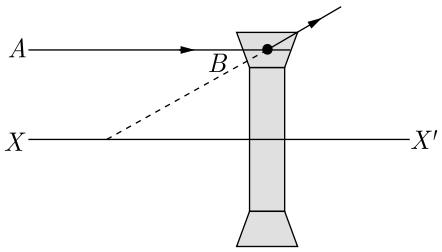
(ii) The angle of incidence (i) = the angle of emergence (e), when the ray suffers minimum deviation.

355. The diagram shows a lens as a combination of a glass block and two prisms. Name the lens formed by the combination. What is the line XX' called? Complete the path of the incident ray AB after passing through the lens. The final emergent ray will either meet XX' at a point or appear to come from a point on XX'.
What is this point called? Label it in your diagram by the letter F.



Ans : SQP 2021

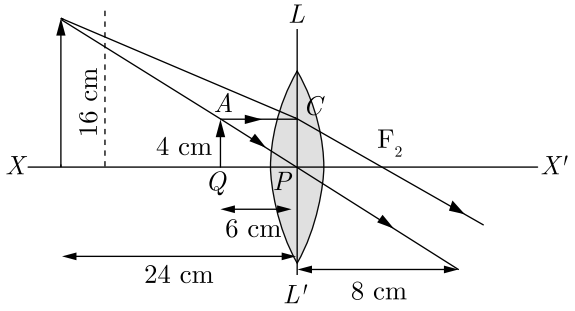
The lens formed by the combination is a concave lens. The line XX' is called the principal axis. The completed ray diagram is as shown in figure below. The emergent rays appears to be coming from a point F on the line XX'. This point is called the second focus of the lens.



356. A convex lens forms an image 16 cm long of an object 4 cm long kept at a distance of 6 cm from the lens. The object and image are on the same side of lens. Draw diagram and find (i) nature of image, (ii) focal length of lens.

Ans : MAIN 2005

(i) Choose a proper scale say, 4 cm = 1 cm. Mark the lens as LPL' on the principal axis XX'. In front of the lens, mark the object OA with distance $OP = 6$ cm and height of object $OA = 4$ cm. Join A to P (optical centre of the lens) and produce it backwards. Mark the image IB such that IB = 16 cm as shown in figure. Measure the distance PI. It comes out to be 24 cm. Thus, the distance of image is equal to 24 cm. The image is virtual and upright.

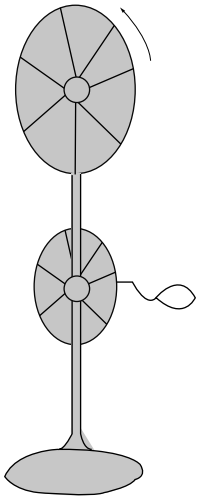


at this point. This (concentrated heat energy) is often sufficient to burn the piece of paper. The required ray diagram is as shown in figure.

351. What is Newton's colour disc? What does the Newton's colour disc experiment establish about the nature of white light?

Ans : COMP 2018

Newton's colour disc is a metallic or cardboard disc painted with seven colours of the spectrum. The sector of each colour is painted in the order and ratio of amount of colour found in solar spectrum, i.e. VIBGYOR. When the disc connected to a wheel is rotated at a high speed in a vertical plane, disc appears dull white. It establishes that recombination of the spectrum colours (VIBGYOR) gives white light.

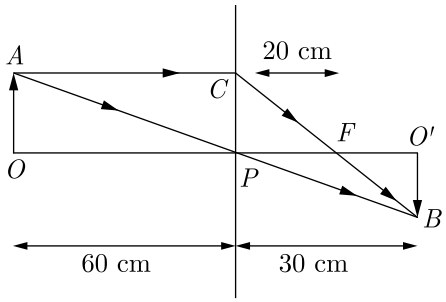


352. Draw a diagram to locate the position of a convex lens kept between a candle and screen separated by a distance of 90 cm so that a small image of the candle half the size of it may be formed on the screen. Deduce the focal length from the diagram.

Ans : SQP 2007

Draw a line OO' 9 cm long to represent the principal axis. OO' represents a distance of 90 cm between the candle and the screen. At the end O, draw a line OA to represent the size of the object and a line $O'B$ at the other end $\frac{1}{2}$ cm long to represent the size of the image. Join AB to cut OO' at P. P is the optical centre of the converging lens L.

From A, draw a ray AC parallel to principal axis. Join C with B. The lens CB meets the principle axis at the point which is the focus of the lens. Measure the distances OP, PF and PO'.



It will be found that $OP = 6$ cm. It thus represent, a distance of 60 cm.

Similarly, $PF = 20$ cm = focal length of the lens and $PO' = 30$ cm. The distance of the image from the lens is thus 30 cm.

353. Give in the tabular form the difference between a Real Image and a Virtual Image.

Ans : MAIN 2010

The difference between real image and virtual image are as follows:

	Real Image	**Virtual Image**
1.	When the rays of light diverging from a point after reflection or refraction actually converge at some point, then that point is the real image of object.	When the rays of light diverging from a point after reflection or refraction appear to diverge from some other point, then the image so formed is called virtual image.
2.	A real image is always inverted and can be taken on the screen.	A virtual image is always erect and cannot be taken on the screen.
3.	A real image is formed by eye, photographic camera, convex lens except when object is very close to the lens, concave mirror except when object is very close to concave mirror.	A virtual image is formed by plane mirror, convex mirror and concave lens.

354. A prism deviates a monochromatic ray of light through an angle 'δ', when the angle of incidence at the surface of the prism is 'i'.

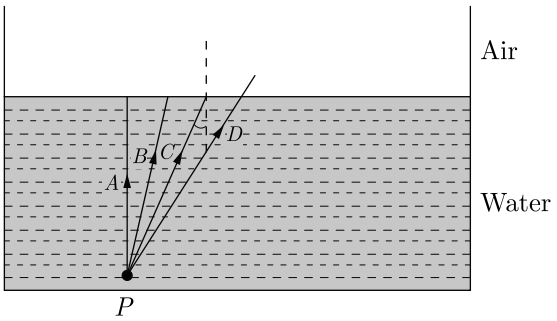
(i) Draw a graph showing the variation of 'δ' with 'i'. On your graph show the angle of minimum deviation.

(ii) What is the relation between the angle of

Click Here to Buy book on Amazon

AB. At the point E, the angle of incidence for the ray DE is $150^\circ - 90^\circ = 60^\circ$ which is equal to the critical angle, so the ray DE is refracted at 90° i.e., it is refracted along EC.

361. The diagram below shows a point source P inside a water container. Four rays A, B, C, D starting from the source P are shown upto the water surface.

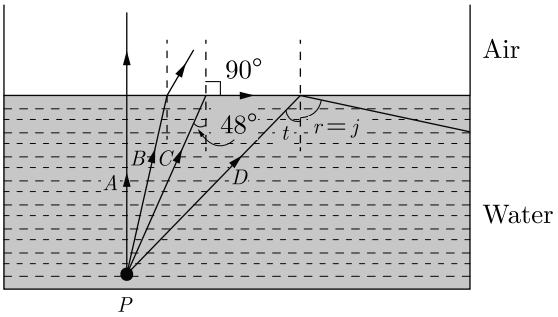


(i) Show in the diagram the path of these rays after striking the water surface. The critical angle for water air surface is 48°.

(ii) Name the phenomenon which the rays B and D exhibit.

Ans : SQP 2017

(i) The diagram is as shown :



(ii) Ray B— Refraction, Ray D — Total internal reflection.

362. A ray of monochromatic light is incident from air on a glass slab:

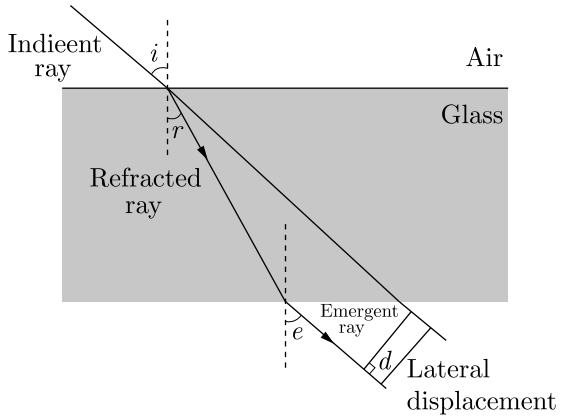
(i) Draw a labelled ray diagram showing the change in the path of the ray till it emerges from the glass slab.

(ii) Name the two rays that are parallel to each other.

(iii) Mark the lateral displacement in your diagram.

Ans :

(i)

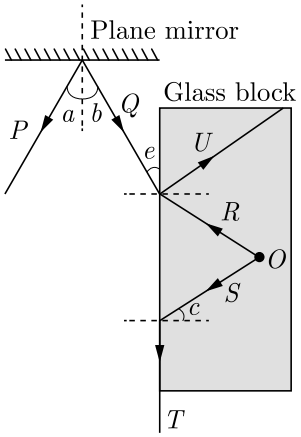


(ii) Two rays that are parallel to each other are incident ray and emergent ray.

(iii) The perpendicular distance between incident ray and emergent ray is the lateral displacement, marked as d in the diagram.

FOUR MARKS QUESTIONS

363. O is a luminescent particle trapped inside a glass block. A student traces the path of rays coming out of it and reflecting over a plane mirror as shown in the diagram below.



Complete the table, using the labels from the figure.

	Description	Label
a.	an angle of reflection on the mirror	a
b.	a partially reflected ray in the glass slab	
c.	a critical angle	
d.	a refracted ray	
e.	an angle of refraction of the ray R	

NODIA

values of angle i. Figure 2 shows the student's results.

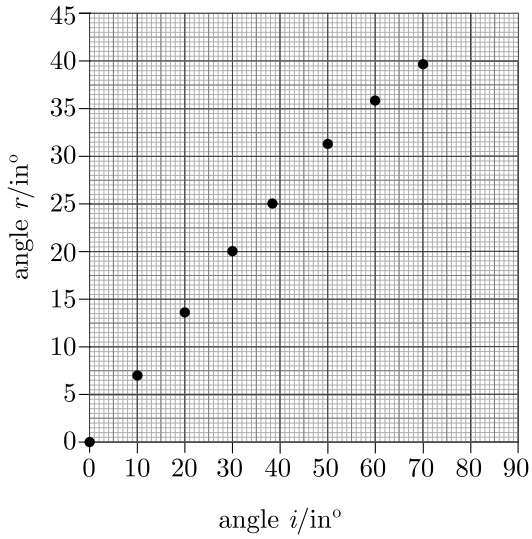


Figure 2

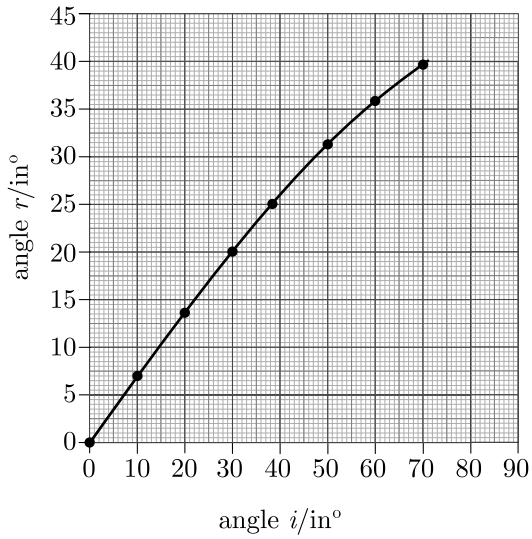
(i) On the graph in Figure 2, draw the best fit curve.

(ii) Use the graph in Figure 2 to estimate the value of angle r when angle i is 80°.

(iii) Describe how angle r changes with angle i for the results shown on the graph in Figure 2.

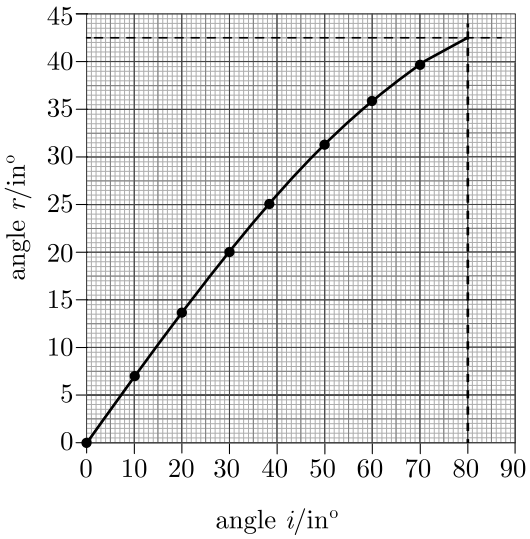
Ans :

(i)



NO NEED TO PURCHASE SAMPLE PAPERS
Download India's Best 20 Sample Papers
DOWNLOAD NODIA APP
Every School conduct Pre-Board
From These Sample Papers

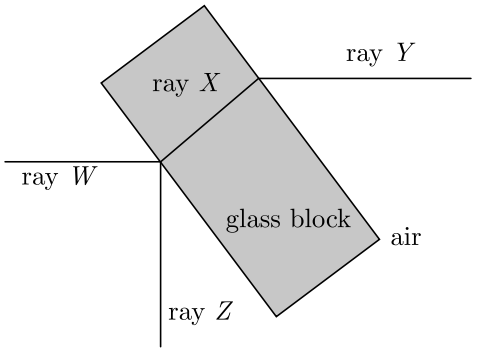
(ii)



From the graph $r = 42^o \pm 2^o$

(iii) As the angle of incidence increases ,the angle of refraction also increases proportionally to the increase of incidence.

398. The diagram shows light shining through a glass block. Some light is refracted and some is reflected.



Which ray represents:

(i) the incident ray in air

(ii) the reflected ray in air

(iii) the refracted ray in air?

Ans :

(i) W

(ii) Z

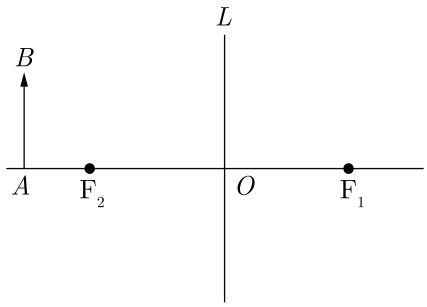
(iii) Y

399. Diagram 1 shows a glass prism which can be used to turn an image the right way up.

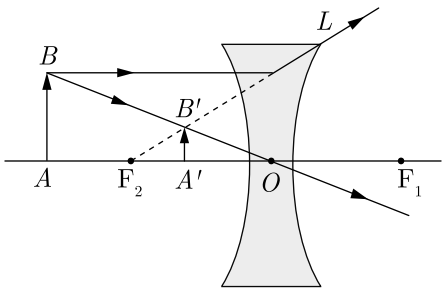
Downloaded from www.pdf.tube

parallel to the principal axis, is incident on the lens and emerges after refraction from it.

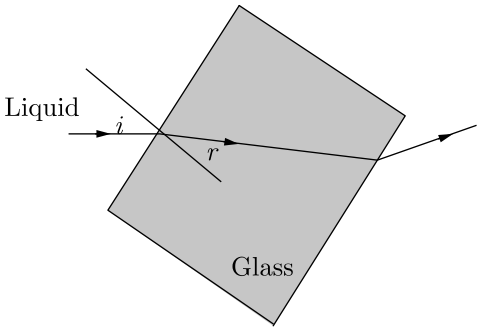
(d) Locate the final image formed.



Ans : MAIN 2013



367. (a) The given diagram shows the path of a ray of light through a rectangular glass block placed in a liquid of uniform density.



(i) Does the light speed up or slow down in glass?

(ii) Give reasons for your answer.

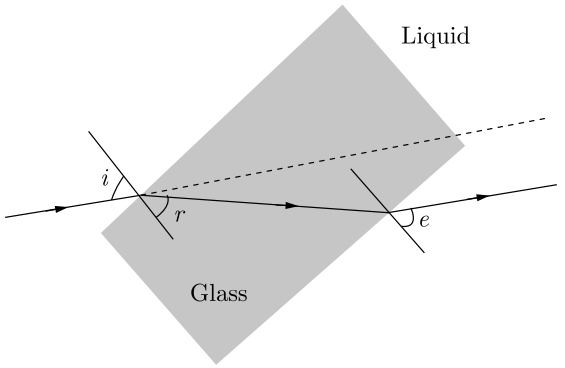
(b) What is the angular deviation of the emergent ray from the glass block with respect to the incident ray?

Ans : COMP 2015

(a) (i) The speed of light slows down.

(ii) In the diagram, the ray of light is travelling from liquid to glass bends towards the normal which implies that glass is optically denser medium than liquid. Hence speed of light slows down.

(b) As shown by dotted line in the diagram, the emergent ray is parallel to the incident ray produced and so there is no angular deviation.



NODIA

368. How will you investigate the existence of ultraviolet and infra-red radiation at the ends of the spectrum?

Ans : SQP 2020

To investigate the infra-red radiation William Herschel in about 1800 moved a blackened bulb thermometer from violet to red end of visible spectrum and noticed the slight rise in temperature. However, when he moved the bulb in the region beyond red there was sudden rise in temperature. This proved the existence of the region of electromagnetic radiations beyond red which produced heating effect but does not produce visible light. Later on Langley of America found that glass allows radiations upto 20000 Å to pass through it. But absorbs higher wavelengths. He obtained the spectrum of arc lamp through a rock salt prism and detected through a thermopile. He found that range of infra-red radiations extends from 7800 Å to 10^7 Å.

To investigate the ultraviolet radiation Prof. J. Ritter in 1801 made incident different radiation from red end to the violet end on the silver chloride solution but the solution remain unaffected. However, beyond the violet end, it first becomes violet and finally turns dark brown or black.

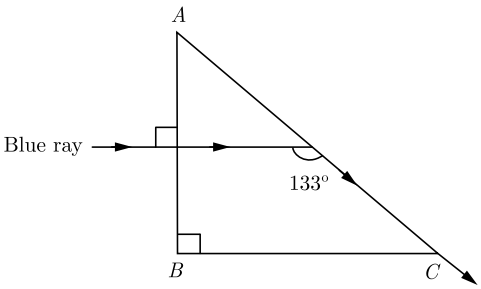
From this experiment he concluded that region of electromagnetic spectrum beyond violet is invisible to human eye but chemically more active than the visible light. These radiations are called ultraviolet radiation or actinic rays which are in the wavelength range from 4000 Å to 135 Å . Besides chemical property these radiations are also detected by the property of fluorescence.

Ans : SQP 2025

	Description	Label
a.	angle of incidence on the mirror	a
b.	partially reflected ray in glass slab	U
c.	a critical angle	C
d.	a refracted ray	Q/T
e.	angle of refraction	90-e

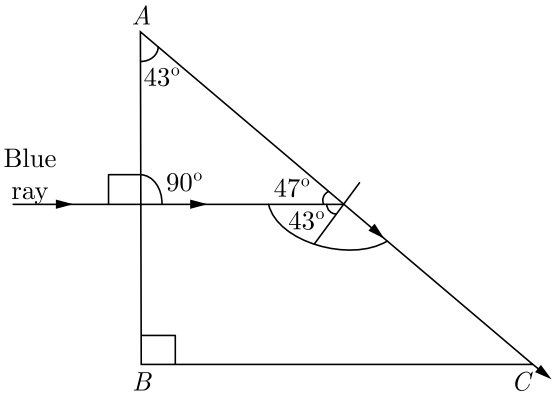
364. The diagram below shows the path of a blue ray through the prism:

1. Calculate the critical angle of the material of the prism for blue colour.
2. What is the measure of the angle of this prism (A)?
3. Which colour should replace the blue ray, for the ray to undergo Total Internal Reflection?



Ans : MAIN 2024

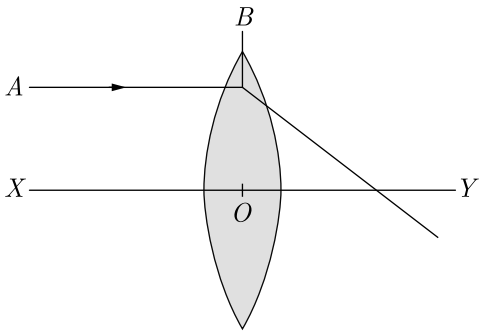
1. Critical angle is 43°



2. From the above figure, Angle of prism = 43°
3. If the blue ray is replaced by indigo or violet, there will be total internal reflection.

Critical angles for indigo and violets are less than that of blue. Hence, the angle of incidence 43° will be greater than the critical angle and total internal reflection will occur.

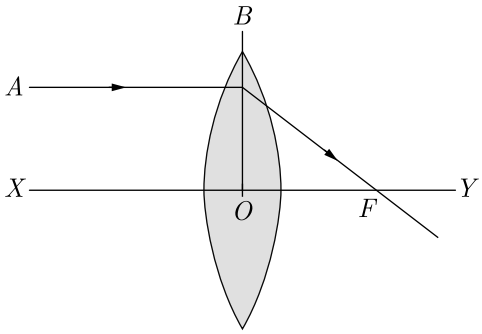
365. The diagram below shows a lens as a combination of a glass block and two prisms. Copy the diagram and answer the following questions :



(i) Name the lens formed by the combination.
(ii) What is the line XY called ?
(iii) Complete the ray diagram and show the path of the incident ray AB after passing through the lens.
(iv) The final emergent ray will either meet XY at a point or appear to come from a point on XY. What is the point called ?

Ans : MAIN 2010

(i) The lens is convex.
(ii) The line XY is called the principal axis of the lens.
(iii)



(iv) The final emergent ray will actually meet OY at a point F, which is known as the principal focus of the lens.

366. The diagram below shows an object AB placed on the principal axis of a lens L. The two foci of the lens are F_1 and F_2. The image formed by the lens is erect, virtual and diminished. Copy the diagram and answer the following questions:

(a) Draw the outline of the lens (L) used.
(b) Draw a ray of light starting from B and passing through O. Show the same ray after refraction by the lens.
(c) Draw another ray from B, which after passing

Click Here to Buy book on Amazon

(ii) $$\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$$

$$\frac{1}{v}=\frac{1}{f}+\frac{1}{u}$$

$$\frac{1}{v}=\frac{1}{8}+\frac{1}{(-24)}$$

$$=\frac{3-1}{24}=\frac{2}{24}=\frac{1}{12}$$

$$v=+12\text{ cm}$$

(iii) Using the expression

$$m=\frac{v}{u}=\frac{12}{-24}=\frac{-1}{2}$$

Negative sign signifies inverted image.

374. The speed of light in glass is 2×10^5 km/s. What is the refractive index of glass?

Ans : COMP 2015

Speed of light in glass $=2\times10^5$ km/s

Refractive index of glass

$$=\frac{\text{Speed of light in vacuum}}{\text{Speed of light in glass}}$$

$$=\frac{3\times10^8\text{ m s}^{-1}}{2\times10^8\text{ m s}^{-1}}=1.5$$

Thus the refractive index of glass is 1.5.

375. The refractive index of glass with respect to air is 1.5. What is the value of the refractive index of air with respect to glass ?

Ans : MAIN 2013

Given, $${}_{\text{air}}\mu_{\text{glass}}=1.5$$

$${}_{\text{glass}}\mu_{\text{air}}=\frac{1}{{}_{\text{air}}\mu_{\text{glass}}}$$

$$=\frac{1}{1.5}=\frac{2}{3}=0.67$$

376. A coin placed at the bottom of a beaker appears to be raised by 4.0 cm. If the refractive index of water is 4/3, find the depth of the water in the beaker.

Ans : SQP 2015

Refractive index of water, $\mu=\frac{4}{3}$

Let real depth $=x$

So, apparent depth $=x-4$

$$\frac{4}{3}=\frac{\text{Real depth}}{\text{Apparent depth}}$$

$$\frac{4}{3}=\frac{x}{x-4}$$

$$4x-16=3x$$

$$4x-3x=16$$

$$x=16$$

Real depth $=16$ cm

377. A pond appears to be 2.7 m deep. If the refractive index of water is 4/3, find the actual depth of the pond.

Ans : MAIN 2020

$$AD=2.7,\ \mu=4/3,\ RD=?$$

$$RD=\mu\times AD=\frac{4}{3}\times2.7$$

378. An object is placed at a distance of 12 cm from a convex lens of focal length 8 cm. Find:
(i) the position of the image
(ii) nature of the image

Ans :

Given, Object distance, $u=-12$ cm

Focal length of lens, $f=+8$ cm

$$\frac{1}{f}=\frac{1}{v}-\frac{1}{u},\text{ we have}$$

$$\frac{1}{v}=\frac{1}{f}+\frac{1}{u}=\frac{1}{8}+\frac{1}{-12}$$

$$=\frac{3-2}{24}=\frac{1}{24}$$

or $$v=24\text{ cm}$$

Image will be real and inverted.

379. In a hospital, an ultrasonic scanner is used to locate tumours in a tissue. What is the wavelength of sound in a tissue in which the speed of sound is 1.7 km s^{-1} ? The operating frequency of the scanner is 4.2 MHz.

Ans : COMP 2006

Speed of sound, $v=1.7\text{ kms}^{-1}=1700\text{ ms}^{-1}$

Frequency of scanner, $f=4.2$ MHz

$$=4.2\times10^6\text{ Hz}$$

Wavelength, $$\lambda=\frac{v}{f}$$

$$=\frac{1700}{4.2\times10^6}$$

$$=0.405\times10^{-3}\text{ m}$$

$$=0.405\text{ mm}$$

380. A candle of size 2.0 cm is placed at 0.25 m from the eye lens. Its image is formed on the retina which is 25 mm behind the eye lens. Find the size of the image.

Downloaded from www.pdf.tube

$$= \frac{1}{20} - \frac{1}{(-20)} = \frac{2}{20}$$

$$f = 10\,\text{cm} = 0.1\,\text{m}$$

Now, $P = \frac{1}{f_e}$

$$P = \frac{1}{0.1\,\text{m}} = +10\,\text{D}$$

391. A light ray enters a liquid at an angle of incidence 45° and it gets refracted in liquid at angle of refraction 30°. Calculate the refractive index of the liquid.

Ans : MAIN 2016

$$\mu = \frac{\sin i}{\sin r} = \frac{\sin 45^\circ}{\sin 30^\circ}$$

As, $\sin 45^\circ = 0.7$

$\sin 30^\circ = 0.5$

$$\mu = \frac{0.7}{0.5} = 1.4$$

392. Calculate the power of the combination formed by placing two thin lenses of power +5 D and −7 D in contact with each other. State whether the combination will be convergent or divergent.

Ans : SQP 2023

Given, $P_1 = +5\,\text{D}$

$P_2 = -7\,\text{D}$

$P = P_1 + P_2$

$= +5\,\text{D} + (-7\,\text{D})$

$= -2\,\text{D}$

The negative sign of the power of the combination shows that the combination will be divergent.

393. An electromagnetic wave travels in vacuum along z-direction. If the frequency of the wave is 30 MHz, what is its wavelength?

Ans : MAIN 2006

Given, $v = 30\,\text{MHz} = 30 \times 10^6\,\text{Hz}$

$v = 3 \times 10^8\,\text{m s}^{-1}$

$\lambda = \frac{v}{V}$

$= \frac{3 \times 10^8\,\text{m s}^{-1}}{30 \times 10^6\,\text{Hz}} = 10\,\text{m}$

394. What is the wavelength of an electromagnetic wave whose frequency is 10^{12} Hz ? Name this electromagnetic wave.

Ans : COMP 2018

Given, $v = 10^{12}\,\text{Hz}$

$v_a = 3 \times 10^8\,\text{m s}^{-1}$

For a wave,

Velocity, v_a = Frequency (v) × Wavelength (λ)

Therefore, wavelength of the wave

$$= \frac{\text{Velocity of the wave } (v_a)}{\text{Frequency } (v)}$$

Wavelength of the wave,

$$\lambda = \frac{3 \times 10^8\,\text{ms}^{-1}}{10^{12}\,\text{Hz}}$$

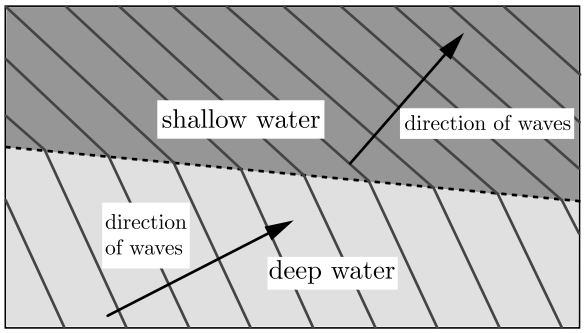
$$= 3 \times 10^{-4}\,\text{m}$$

$$= 3 \times 10^{-2}\,\text{cm}$$

Such waves are heat waves or infra-red waves whose wavelength varies from 10^{-2} to 10^{-4} cm.

CASE BASED QUESTION

395. The diagram represents water waves travelling from deep water into an area of much shallower water.



(i) State the name of the effect shown in this diagram.

(ii) Complete the following sentence
When the waves go from deep water to shallow water, the ..... (Frequency/ wavelength) decreases.

(iii) Explain another change which can be seen from the diagram when the waves go from deep water to shallow water.

Ans :

(i) refraction

(ii) wavelength

(iii) (a) change in direction
(b) moves towards the normal
(c) decrease in speed

NODIA

385. The refractive index of glass is $\frac{3}{2}$. What is the critical angle for glass air surface ? $(\sin 42^\circ = 2/3)$

Ans : MAIN 2020

Given, $\mu = \frac{3}{2}$

If i_C is the critical angle, then

$$\sin i_C = \frac{1}{\mu} = \frac{1}{\frac{3}{2}} = \frac{2}{3}$$

$$\sin i_C = \sin 42^\circ$$

(since $\sin 42^\circ = 2/3$)

$$i_C = 42^\circ$$

386. The speed of light in air is $3 \times 10^8\ \text{ms}^{-1}$. Calculate the speed of light in glass. The refractive index of glass is 1.5.

Ans : SQP 2005

Given, $c = 3 \times 10^8\ \text{ms}^{-1}$

$$\mu = 1.5$$

$$\mu = \frac{c}{v}$$

$$1.5 = \frac{3 \times 10^8}{v}$$

$$v = \frac{3 \times 10^8}{1.5}$$

$$= 2 \times 10^8\ \text{ms}^{-1}$$

387. A ray of light of wavelength $5400\ \text{Å}$ suffers refraction from air to glass. Taking ${}_a\mu_g = \frac{3}{2}$, find the wavelength of light in glass.

Ans : COMP 2001

Given, $\lambda = 5400\ \text{Å} = 5400 \times 10^{-10}\ \text{m}$

$${}_a\mu_g = \frac{3}{2}$$

As frequency remains same.

$$v = f\lambda$$

$$3 \times 10^8 = f \times 54 \times 10^{-8}$$

$$f = \frac{3 \times 10^8}{54 \times 10^{-8}}$$

$$= \frac{3}{54} \times 10^{16} \text{ or } \frac{300}{54} \times 10^{14}$$

$$f = 5.5 \times 10^{14}\ \text{Hz}$$

Again, ${}_a\mu_g = \frac{3}{2}$

$${}_a\mu_g = \frac{c}{\text{velocity in glass}}$$

$$v = \frac{c}{{}_a\mu_g}$$

$$= \frac{3 \times 10^8}{3} \times 2 = 2 \times 10^8\ \text{ms}^{-1}$$

Now, $v = f\lambda$

$$2 \times 10^8 = 5.5 \times 10^{14} \times \lambda$$

$$\lambda = \frac{2 \times 10^8}{5.5 \times 10^{14}}$$

$$= 0.36 \times 10^{-6} = 3600\ \text{Å}$$

388. A combined lens is formed by combining two lenses of 9.5 D and –1.5 D powers. What is the nature and power of this combined lens?

Ans : MAIN 2008

Given, $P_1 = 9.5\ \text{D},\ P_2 = -1.5\ \text{D}$

$$P = P_1 + P_2 = 9.5\ \text{D} + (-1.5\ \text{D})$$

$$= +8.0\ \text{D}$$

The positive sign of the power of the combined lens shows that combined lens is convergent in nature.

389. A postage stamp appears raised by 7.0 mm when placed under a rectangular glass block of refractive index 1.5. Find the thickness of the glass block.

Ans : SQP 2022

Let the thickness of the glass block be t mm.
According to the question,
Apparent depth of the postage stamp $= (t - 7)$ mm
Refractive index of glass

$$= \frac{\text{Real thickness of the glass block}}{\text{Apparent thickness of the glass block}}$$

$$1.5 = \frac{t}{t-7}$$

$$1.5t - 10.5 = t$$

$$t = \frac{10.5}{0.5} = 21\ \text{mm or } 2.1\ \text{cm}$$

390. A candle is burning at some distance on one side of a glass box. The image of the candle is formed of same size on a screen kept at 0.20 m on the other side of the box. Name the lens arrangement in the box. What will be its power?

Ans : COMP 2011

In the box, there is a convex lens.

As magnification, $m = \frac{v}{u} = 1$

Given, $v = u = 0.20\ \text{m} = 20\ \text{cm}$

$$u = -20\ \text{cm}$$

$$v = 20\ \text{cm}$$

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

Click Here to Buy book on Amazon

Ans : COMP 2016

Given, $u = 0.25\text{m} = -25\text{ cm}$

$v = 25\text{ mm} = 2.5\text{ cm}$

$$\frac{h_i}{h_o} = \frac{v}{u}$$

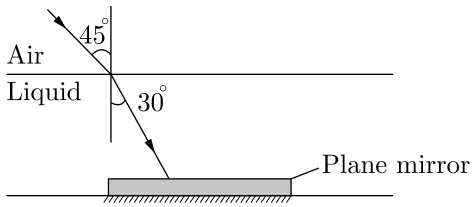
$$h_i = \frac{v}{u} \times h_o$$

$$= \frac{2.5\text{ cm}}{-25\text{ cm}} \times 2.0\text{ cm}$$

$$= -0.2\text{ cm}$$

The size of the image is 0.2 cm and the negative sign shows that it is inverted.

381. A ray of monochromatic light enters a liquid as shown in the diagram. Angle of incidence is 45° and the angle of refraction is 30°.

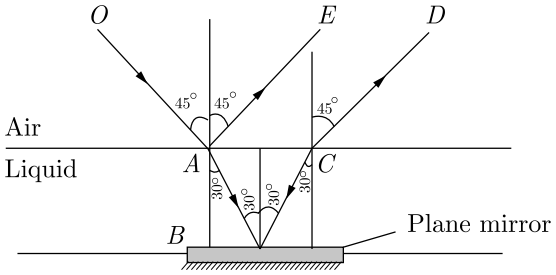


(i) Show in the diagram the path of the ray after it strikes the mirror and goes into air.

(ii) Calculate the refrative index of the liquid.

Ans : MAIN 2019

(i)



(ii) Refractive index of the liquid

$$_a\mu_l = \frac{\sin 45^\circ}{\sin 30^\circ}$$

$$= \frac{1/\sqrt{2}}{1/2} = \frac{2}{\sqrt{2}} = 1.414$$

382. The power of a lens is - 5D.

(i) Find its focal length.

(ii) Name the type of lens.

Ans : SQP 2009

(i) $$f = \frac{1}{p} = \frac{1}{-5} = -0.2\text{ m} = 20\text{ cm}$$

(ii) Concave

383. A radio can tune in to any station in 7.5 MHz to 12 MHz band, what is the corresponding wavelength band?

Ans : SQP 2014

Range 7.5 MHz to 12 MHz

$$\lambda_1 = \frac{3 \times 10^8\text{ m s}^{-1}}{7.5 \times 10^6\text{ Hz}} = 40\text{ m}$$

$$\lambda_2 = \frac{3 \times 10^8\text{ m s}^{-1}}{12 \times 10^6\text{ Hz}} = 25\text{ m}$$

Corresponding wavelength band 40 m to 25 m.

384. Red light of wavelength 6600 Å travelling in air gets refracted in water. If the speed of light in air is $3 \times 10^8\text{ ms}^{-1}$ and refractive index of water is 4/3, find (i) the frequency of light in air, (ii) the speed of light in water and (iii) the wavelength of light in water.

Ans : COMP 2011

Given, $\lambda_{air} = 6600\text{ Å} = 6600 \times 10^{-10}\text{ m}$

$c = 3 \times 10^8\text{ ms}^{-1}$

$$\mu = \frac{4}{3}$$

(i) From relation $v = f\lambda$

Frequency of light in air,

$$f_{air} = \frac{c}{\lambda_{air}}$$

$$= \frac{3 \times 10^8}{6600 \times 10^{-10}}$$

$$= 4.54 \times 10^{14}\text{ Hz}$$

(ii) From relation $\lambda = \frac{c}{f}$

Speed of light in water

$$v = \frac{c}{\mu} = \frac{3 \times 10^8}{4/3}$$

$$= 2.25 \times 10^8\text{ ms}^{-1}$$

(iii) Since the frequency of light remains unchanged in refraction, so

$$f_{water} = f_{air} = 4.54 \times 10^{14}\text{ Hz}$$

Now, speed of light in water

$$v = f_{water} \times \lambda_{water}$$

$$\lambda_{water} = \frac{v}{f_{water}}$$

$$= \frac{2.25 \times 10^8}{4.54 \times 10^{14}}$$

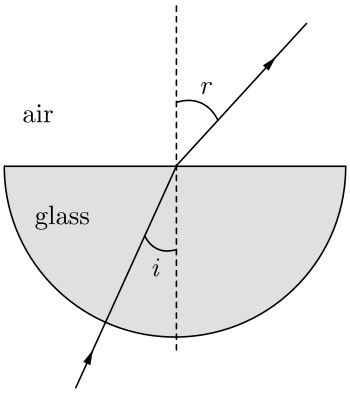
$$= 4.956 \times 10^{-7}\text{ m or } 4956\text{ Å}$$

$$\lambda_{water} = \frac{\lambda_{air}}{\mu_{water}}$$

$$= \frac{6600}{4/3} = 4950\text{ Å}$$

NODIA

396. A student investigates the way light passes through glass. The diagram shows the path of a ray of light through the glass.

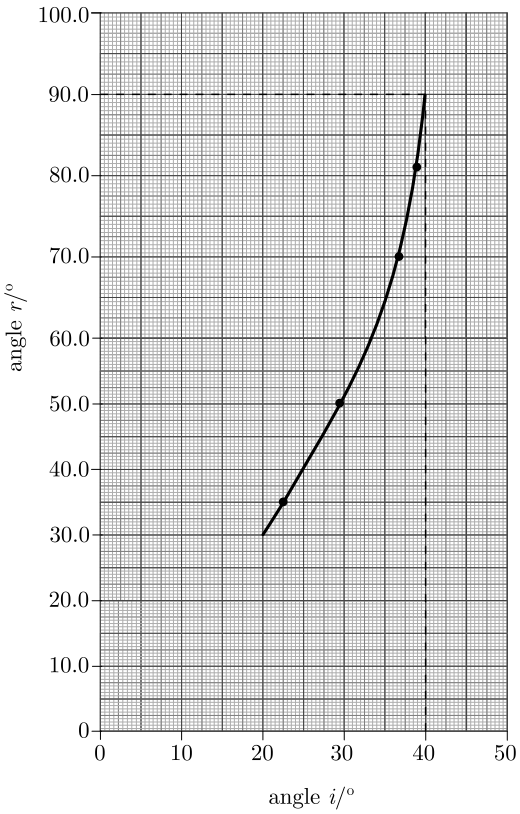


(i) State the scientific name for the dotted line in the diagram.

(ii) The student measu
She plots some of her results on the graph. The table shows results that she has not plotted.

angle i	**angle** r
0^o	0^o
6^o	9^o

(a) Plot these results on the graph.



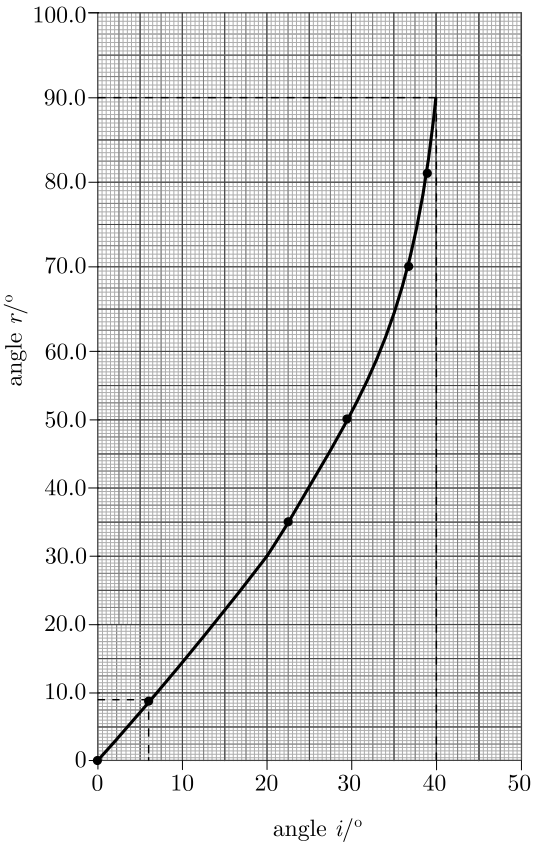
(b) Continue the line on the graph through the results you have plotted.

(c) Write down the value of angle i when angle $r = 90^o$.

Ans :

(i) Normal

(ii) (a)



(b) straight line

(c) 40^o(From the graph)

397. A student is investigating the refraction of light. Figure 1 shows part of the apparatus and the angles to be measured.

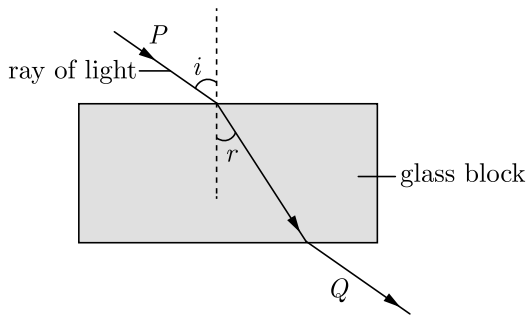


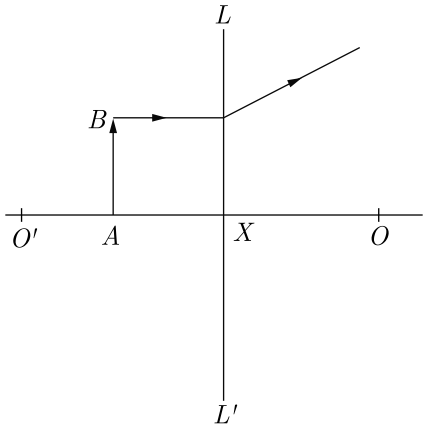
Figure 1

The student measures angle r for several different

Downloaded from www.pdf.tube

In this process ultraviolet radiations are passed through a thin tube containing a quinine-sulphate solution, where they get absorbed and emits the waves of longer wavelengths which are transmitted as bluish light. UV radiations are absorbed by glass prism but its spectrum can be obtained by using quartz prism.

369. Study the diagram below and answer the following questions :



(i) Name the lens LL'.
(ii) What are the points O and O' called ?
(iii) Between which points will the image of the object AB be formed ?
(iv) What is the nature of the image ?

Ans : MAIN 2021

(i) The lens LL' is concave.
(ii) They are called first and second focal points.
(iii) Between A and X.
(iv) Diminished, virtual and erect.

NUMERICAL QUESTION

370. An object is placed at a distance 24 cm in front of a convex lens of focal length 8 cm.
(a) What is the nature of the image so formed?
(b) Calculate the distance of the image from the lens.

Ans : SQP 2025

(a) Real, inverted

(b) $$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$$
$$\frac{1}{v}-\frac{1}{-24}=\frac{1}{8}$$
$$\frac{1}{v}=\frac{3-1}{24}\quad v=12\text{ cm}$$

(identifying 'u' and 'f' with correct sign convention)

371. The image of a candle flame placed at a distance of 36 cm from a spherical lens, is formed on a screen placed at a distance of 72 cm from the lens. Calculate the focal length of the lens and its power.

Ans : MAIN 2024

Using lens formula,
$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$$
$$\frac{1}{72}+\frac{1}{36}=\frac{1}{f}$$
$$\frac{3}{72}=\frac{1}{f}$$
$$f=24\text{ cm}$$
$$\text{Power of the lens}=\frac{1}{f}=\frac{100}{24}=4.17\text{ D}$$

NODIA

372. A lens of focal length 20 cm forms an inverted image at a distance 60 cm from the lens.
(i) Identify the lens.
(ii) How far is the lens present in front of the object?
(iii) Calculate the magnification of the image.

Ans : MAIN 2020

Given, $f=20\text{ cm}$, $v=60\text{ cm}$
(i) Convex lens.
(ii) From lens formula,
$$\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$$
$$\frac{1}{u}=\frac{1}{v}-\frac{1}{f}=\frac{1}{60}-\frac{1}{20}$$
$$=\frac{1-3}{60}=-\frac{2}{60}=\frac{-1}{30}$$
$$u=-30\text{ cm}$$
(iii) Magnification is given by
$$m=\frac{v}{u}=\frac{60}{-30}=-2$$

373. An object is placed at a distance 24 cm in front of a convex lens of focal length 8 cm.
(i) What is the nature of the image so formed?
(ii) Calculate the distance of the image from the lens.
(iii) Calculate the magnification of the image.

Ans : SQP 2019

Given, $u=-24$ cm, $f=+8$ cm,
(i) Real, inverted and diminished.

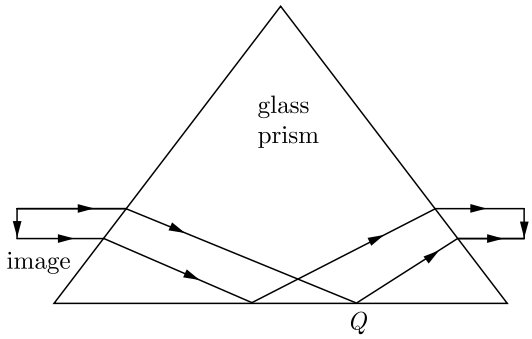


Diagram 1

(i) In diagram 1, total internal reflection occurs at Q. Explain why total internal reflection occurs at Q.

(ii) The way in which the light changes direction at P is shown in diagram 2. Mark on the diagram (i) for the angle of incidence and (r) for the angle of refraction for the ray of light shown.

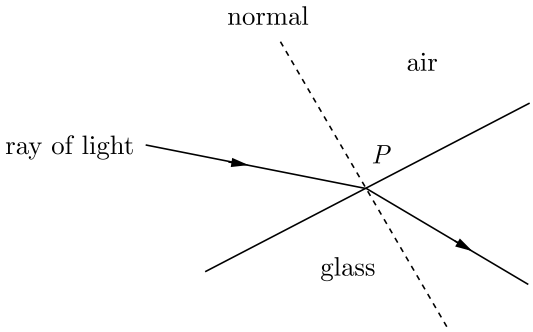


Diagram 2

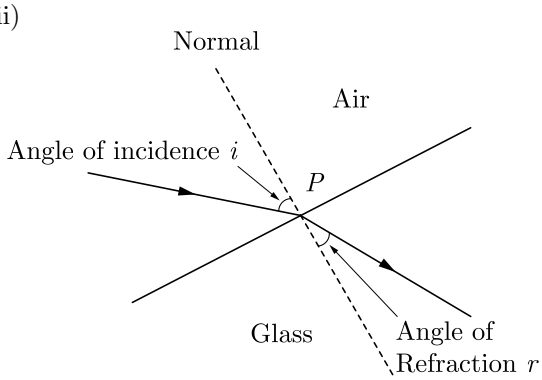
(iii) Which of these is correct for the light as it enters the prism at P?

A frequency decreases
B frequency increases
C speed decreases
D speed increases

Ans :

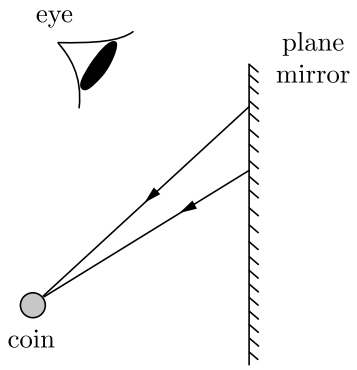
(i) Angle of incidence in glass greater than critical angle (42°). So the total internal reflection occurs at surface Q.

(ii)



(iii) Speed of light decreases

400. A girl looks at the reflection of a coin using a plane mirror.



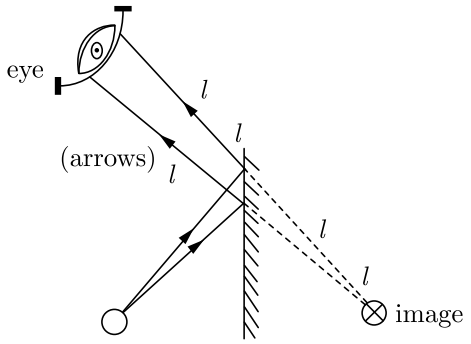
(i) Complete the ray diagram to show how the rays of light enter her eye.

(ii) Mark an X on the diagram to show where the girl sees the image.

(iii) What type of image does she see? Is it real or virtual? Explain your answer.

Ans :

(i, ii)



(iii) It is a virtual image.

401. The linear magnification of a thin lens is given the symbol M. The following equation for M is used for lenses in cameras.

$$M = \frac{f}{(d - f)}$$

Where f is the focal length of the lens and d is the distance between the lens and an object.

A lens has a focal length of 12 cm.

(i) Use the equation to calculate M when the distance from an object to the lens is 14 cm

(ii) Use the equation to calculate M when the distance from an object to the lens is 11 cm

Ans :

Click Here to Buy book on Amazon

Speed of sound in air at STP is $332\,\text{ms}^{-1}$. It increases with the rise in temperature.

5. REFLECTION OF SOUND

Sound waves follow the laws of reflection in exactly the same way as light waves. But sound waves due to their large wavelengths do not require very smooth reflectors.

6. ECHO

Sound is produced by any object which vibrates mechanically (physically). Sound waves are reflected from large obstacles. Its example in nature is echo. Therefore, echo is the sound heard after reflection from a large obstacle (such as high building, hillock, a wall, a ship, etc.) after the original sound from the given source dies off.

$$\nu = \frac{2 \times d}{t}$$

Persistence of hearing (0.1 s) is the time for which the sensation of any sound persists in a human ear, after the exciting stimulus ceases to act. Hence, we can hear the echo only if it reaches the ear 0.1 second after the original sound is heard. If the sound is heard within 0.1 second, the original sound and echo cannot be distinguished.

The conditions for the formation of echo are:

(i) The size of the obstacle/reflector must be large compared to the wavelength of the incident sound.

(ii) The minimum distance between the source of sound and the reflector should be at least 17 m.

(iii) The intensity or loudness of sound should be sufficient so that it can be clearly heard after reflection.

7. NATURAL FREQUENCY

The number of vibrations executed by a body vibrating freely in one second is called its natural frequency.

8. FREE VIBRATIONS OR NATURAL VIBRATIONS

If a body vibrates with its natural frequency without the help of any external periodic force, it is said to be executing free vibrations.

9. FORCED VIBRATIONS

When a body oscillates/vibrates under the influence of an external periodic force with a frequency different from its natural frequency, the body is said to execute forced vibrations, e.g. swing pushed at regular intervals, sound board of all stringed musical instruments (like violin, guitar etc.)

10. RESONANCE

It is the phenomenon in which body vibrates under the influence of periodic force where frequency of the applied periodic force is equal to the natural frequency of the vibrating body. In this case the body begins to vibrate with increased amplitude.

11. DAMPED VIBRATIONS

When a body vibrates with decreasing amplitude with time, its vibrations are said to be damped vibrations.

12. FREQUENCY OF A STRETCHED STRING

The frequency of a stretched string is

(i) inversely proportional to the length (l) of the string, i.e.

$$\nu \propto \frac{1}{l}$$

When T and m are constants.

(ii) directly proportional to the square root of the tension (T),

i.e. $$\nu \propto \sqrt{T}$$

When l and m are constants.

(iii) inversely proportional to the square root of mass per unit length of the string, i.e.

$$\nu \propto \frac{1}{\sqrt{m}}$$

When l and T are constants.

$$\nu \propto \frac{1}{l}\sqrt{\frac{T}{m}}$$

$$\nu = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

$$\nu = \frac{1}{2l}\sqrt{\frac{T}{\pi r^2 \rho}}$$

where $m =$ Volume of unit length of the string $(\pi r^2 \times 1) \times$ density of the material of the string wire (ρ)

$$\nu \propto \frac{1}{r} (r = \text{Radius of string})$$

when l, T and ρ are constants.

and $$\nu \propto \frac{1}{\sqrt{\rho}}$$

when l, T and r are constants.

13. MUSICAL SOUND

A sound which produces a pleasing, soothing and agreeable effect on the listener. Its wave form is periodic and regular with no abrupt change in its amplitude.

NODIA

CHAPTER 5

SOUND

SUMMARY

1. WAVES

Wave is a form or pattern of periodic disturbance. Wave motion is a process of energy transfer in a medium in the form of disturbance due to the repeated periodic motion of the particles of the medium about their mean position. In this process energy is handed over from one particle to another without actual movement of the particles from their mean position.

2. TYPE OF WAVES

2.1 On the Basis of the Requirement of the Medium

On the basis of the requirement of the medium, waves can be classified as follows :

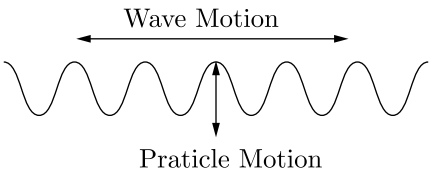
1. Mechanical or Elastic Waves
Mechanical or elastic waves which require material medium for their propagation, e.g. waves on water surface, waves on coiled springs and on stretched springs, sound waves, etc.

2. Electromagnetic Waves
The waves which do not require material medium for their propagation, e.g. light waves, X-rays, microwaves, etc.

2.2 On the Basis of Vibration of Particle

On the basis of vibration of particle waves can be classified as follows :

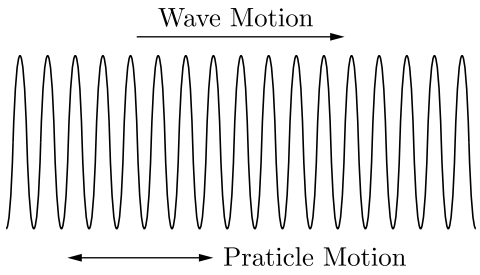
1. Transverse Waves
Transverse wave is the wave in which the particles of the medium vibrate about their mean position in a direction perpendicular to the direction of propagation of wave. It travels in the form of crests and troughs.



Transverse Wave

2. Longitudinal Waves

Longitudinal wave is the wave in which the particles of the medium vibrate about their mean position, parallel to the direction of propagation of wave. These waves consist of series of compressions and rarefactions.



Longitudinal wave

NODIA

3. RANGE OF HEARING

Audible range is the frequency range of audible sound from 20 Hz to 20000 Hz. The sound having frequency below 20 Hz are called infrasonic. These are produced by earthquakes, volcanic eruptions, whales, elephants, etc.

Sound with frequencies above 20 kHz, i.e. above the audible range are called ultrasonic waves or ultrasound. These are produced by bats, dogs, cats, birds, porpoises and insects. Infrasonic and ultrasonic waves are not heard by human ear.

4. RELATION BETWEEN WAVE VELOCITY AND WAVELENGTH

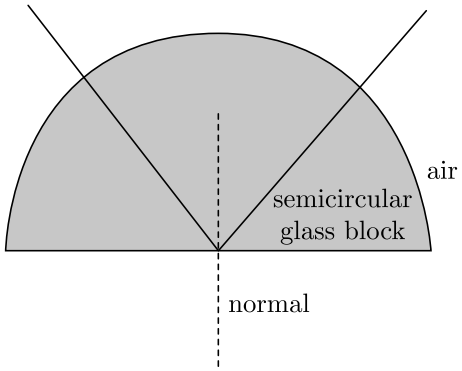
Wave velocity (v) is related to wavelength (λ) and frequency (ν) by the relation

$$v = \nu\lambda$$

(i) $$M = \frac{12}{(14-12)}$$
$$= 6.0$$

(ii) $$M = \frac{11}{(14-11)}$$
$$= \frac{11}{3}$$
$$= 3.66$$

402. The diagram shows total internal reflection in a semicircular glass block.



(i) Use a protractor to measure the angle of incidence shown on the diagram and write the angle.
(ii) State the equation linking refractive index and critical angle.

Ans :

(i) Angle between the ray and the normal is measured (approx. 35°)
(ii) Refractive index $= \frac{1}{\sin C}$

Where C is the critical angle.

www.nodia.in

Downloaded from www.pdf.tube

14. NOISE

It is sound which produces unpleasant effect on listener. Its wave form is irregular, non-periodic with sudden change in its amplitude.

15. CHARACTERISTICS OF SOUND

A sound is identified and interpreted by three characteristics-loudness, pitch and quality. All the three are subjective description of sound. Although they are related to objectively defined quantities-loudness is related to intensity, pitch is related to frequency and quality is related to waveform of the sound wave.

15.1 Intensity

Intensity of sound at any point in space is defined as the amount of vibrational energy passing per unit time per unit area around that point in a direction normal to the area. Its SI unit is $\mathrm{W\,m^{-2}}$. It is a physical quantity.

15.2 Loudness

Loudness is the sensation produced in the ear which enables to distinguish between a loud and a faint sound. It depends upon intensity of sound and sensitiveness of the ear. It is measured in terms of bel. It is not a physical quantity. Intensity or loudness depends upon the following factors. Intensity of sound is directly proportional to

(i) square of the amplitude (A^2) of the vibration of the vibrating body.
(ii) surface area (A) of the medium
(iii) density (ρ) of the medium
(iv) square of the frequency (ν^2) of the source
(v) motion of the medium and
(vi) inversely proportional to the square of the distance of the listener from the source of sound.

15.3 Pitch

Pitch of a sound is that subjective property which distinguishes a sharp sound from a dull sound. Pitch depends on an objective quantity frequency of the source (ν).

15.4 Quality or Timbre

Quality or timbre or tone colour is that subjective characteristic of sound which enables us to distinguish between two sounds of the same loudness and the same pitch but emitted by two different sources. The quality of sound depends on the waveform which is determined by the number of overtones present and their respective intensities.

NODIA

16. NOISE POLLUTION

Noise pollution is displeasing human, animal or machine created sound that disrupts the activity or balance of human/animal life.

1. The word noise is originated from a Latin word nausea meaning seasickness.
2. Noise can damage physiological and psychological health.
3. Noise pollution has many harmful effects like annoyance and aggression, hypertension, high stress levels, tinnitus, hearing loss, sleep disturbances, etc.
4. The intensity of a sound wave of the largest amplitude tolerable to the human ear is $1.07 \times 10^{-4}\,\mathrm{W\,cm^{-2}}$.
5. The pressure amplitude of the faintest sound wave that can be heard is about $3 \times 10^{-5}\,\mathrm{Pa}$ and the corresponding intensity is about $10^{-12}\,\mathrm{Wm^{-2}}$.
6. The ear is sensitive over extremely large range of intensities which is logarithmic intensity scale.
7. The intensity level β of a sound wave is defined by the equation
$$\beta = 10 \log_{10} \frac{I}{I_0}$$
where, I_0 is an arbitrary reference intensity which is taken as $10^{-12}\,\mathrm{Wm^{-2}}$. This corresponds roughly to the faintest sound that can be heard.
8. Intensity levels are expressed in decibels. If the intensity of a sound wave $I_0 = 10^{-12}\,\mathrm{Wm^{-2}}$, the intensity level is 0 dB. The maximum intensity that the ear can tolerate is about $1\,\mathrm{Wm^{-2}}$ corresponds to an intensity level of 120 dB.
$$1 \text{ decibel} = \frac{1}{10} \text{ bel}$$
9. This unit was named in the honour of Alexander Graham Bell.

DOWNLOAD INDIA'S BEST STUDY MOBILE APP
- 20 Sample Paper with Solutions
- Chapterwise Question Bank of All Subject
- Previous 15 Years Solved Papers
- Case Study Questions with full Solutions
Search by NODIA on Play Store to Download App

Ans : MAIN 2022

The total distance between a sound source and the reflector is twice that. So, if the obstacle is at least 17 m away, then after 0.1 second, the reflected sound or the echo is clearly detected. Hence, to hear a clear echo, the minimum distance between the reflecting surface and the observer is 17 m.
Thus (b) is correct option.

13. Bats can catch their prey by using the principle of .....
(a) refraction of sound
(b) reflection of sound
(c) concept of echo
(d) both (a) and (c)

Ans : SQP 2002

Bats can catch their prey by using the principle of echo which is based on the reflection of sound.
Thus (d) is correct option.

14. Sound travels in the form of .....
(a) crest
(b) trough
(c) compression and rarefactions
(d) all of the above

Ans : COMP 2006

Thus (d) is correct option.

15. SONAR is a technique used to .....
(a) detect the impurities present in sea water
(b) detect the depth of sea bed
(c) detect the submarine inside sea
(d) determine the size of blue whale

Ans : MAIN 2010

The sonar technique is used to determine the depth of the sea and to locate underwater hills, valleys, submarine, icebergs, sunken ship etc.
Thus (b) is correct option.

16. The spread of a glacier in the arctic region can be judged by a submarine by using the principle of
(a) reflection of sound
(b) refraction of sound
(c) repetition of sound
(d) none of the above

Ans : SQP 2016

The spread of a glacier in the arctic region can be judged by a submarine by using the principle of reflection of sound
Thus (a) is correct option.

17. Modern super sonic war planes use the principle of..... while detecting their targets.
(a) SONAR (b) echo
(c) reverberation (d) none of these

Ans : MAIN 2002

Modern super sonic war planes use the principle of echo while detecting their targets.
Thus (b) is correct option.

18. A person standing between two cliffs hears two echo one after 3 s and another after 4 sec, so time taken for first echo is ..... and that for second echo is .....
(a) 3 s, 7 s (b) 7 s, 7 s
(c) 3 s, 4 s (d) 3 s, 1 s

Ans : COMP 2005

Shorter time is for the first cliff and longer time is for second cliff.
Thus (c) is correct option.

19. Given below is a diagram showing a set of percussion instruments (i.e., producing sound on being struck).

Which of the following statements is not true about the percussion instrument ?
(a) When the vibrating surface is touched, then sound will stop
(b) These instruments can produce only loud sounds
(c) The surface of the instrument vibrates when struck, thus producing sound
(d) Louder sound can be produced, if hit with greater force

Ans : COMP 2009

Percussion instruments produce sound when its membrane is struck, sound will be louder when struck with greater force. When vibrating surface is touched, then the sound will stop.
Thus (b) is correct option.

Click Here to Buy book on Amazon

(i) The time in which the boy hears the echo is
(a) 1 s (b) 0.5 s
(c) 1.5 s (d) 2 s

Ans : COMP 2020

Echo heard by the boy is only once when whistle stops.

$$t = \frac{1}{2}\text{ s} = 0.5\text{ s}$$

Thus (b) is correct option.

(ii) The distance at which the boy is standing from the wall
(a) 160 m (b) 240 m
(c) 320 m (d) 80 m

Ans : SQP 2011

$$\text{Time} = \frac{2d}{v}$$

Distance between the boy and the wall

$$\frac{\text{time} \times v}{2} = d$$

$$d = \frac{0.5 \times 320}{2} = 80\text{ m}$$

Thus (d) is correct option.

(iii) If the speed of sound is increased by $16\,\text{ms}^{-1}$ and the boy moves 4 m away from the wall, then in how much time will he hear the echo of the first whistle?
(a) 0.525 s (b) 0.5 s
(c) 0.48 s (d) 0.3 s

Ans : MAIN 2000

According to the question,

$$\text{If speed of sound} = (320 + 16)\,\text{ms}^{-1}$$

$$= 336\text{ m/s}$$

Distance between boy and wall

$$= d + 4 = 84\text{ m}$$

$$\text{Tune of echo, } t = \frac{2(d+4)}{v}$$

$$= \frac{2 \times (84)}{336} = 0.5\text{ s}$$

Thus (b) is correct option.

(iv) In which of the following timings of reflections of the whistle, the echo cannot be heard?
(a) 0.05 s (b) 0.12 s
(c) 0.2 s (d) 0.11 s

Ans : COMP 2006

Time of hearing an echo $t \geq 0.1\,\text{s}$
Thus (a) is correct option.

8. Sound waves are waves that are produced due to .....
(a) vibrations of particles
(b) disturbance of particles
(c) turbulence of particles
(d) all of the above

Ans : SQP 2015

Sound is produced when something vibrates. The vibrating body causes the medium (water, air, etc.) around it to vibrate. These vibrations travel as longitudinal waves in air, which we hear as sound. Thus (d) is correct option.

9. Velocity of sound is constant in .....
(a) all mediums
(b) vacuum
(c) homogeneous medium
(d) heterogeneous medium

Ans : COMP 2013

Velocity of sound is constant in homogeneous medium.
Thus (c) is correct option.

10. The repetition of sound heard in a cave or empty room is a case of .....
(a) superposition (b) echo
(c) reverberation (d) interpolation

Ans : SQP 2010

The repetation of sound heard in a cave or empty room is a case of reverberation
Thus (c) is correct option.

11. Amphitheatres and auditorium walls are fitted with ..... to avoid the echoing of sound.
(a) sound absorbers such as foam board
(b) wooden wall
(c) granite
(d) Italian marble

Ans : MAIN 2007

The roof and walls of the auditorium or cinema hall are generally covered with sound absorbent materials like draperies or compressed fibreboard (foam board) to reduce reverberation. These materials reduce the formation of echoes by absorbing sound waves.
Thus (a) is correct option.

12. Echo occurs when the distance between source and listener is .....
(a) 17 m (b) greater than 17 m
(c) 10 m (d) 34 m

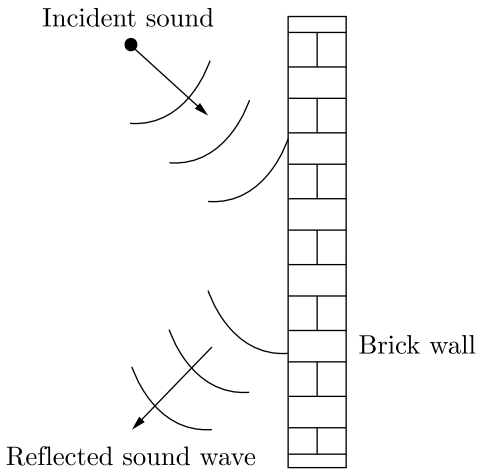
NODIA

25. Which of the following does not produce a sound wave ?
(a) A bell ringing under water
(b) An explosion in outer space
(c) A gun fired in a room with no echoes
(d) A hammer hitting a block of rubber

Ans : SQP 2017

An explosion in outer space because sound needs a medium to travel. As in outer space, there is no atmosphere, sound of explosion will not be heard.
Thus (b) is correct option.

26. A sound wave is reflected from a brick wall. Compared with the incident wave, the reflected wave has



(a) a greater amplitude
(b) a shorter wavelength
(c) the same velocity
(d) the same speed

Ans : MAIN 2004

The reflected wave would have a lower amplitude (since wall absorbs some of the sound energy), same frequency wavelength and speed but different velocities, since the direction of the wave has changed.
Thus (d) is correct option.

27. The frequency of a source is 20 kHz. The frequency of sound wave produced by it in water and air will be
(a) $>$ 20 kHz
(b) $<$ 20 kHz
(c) same as that of source
(d) depend upon velocity

Ans : SQP 2019

As the frequency of source 20 kHz, frequency of sound produced by it in water and air will be constant 20 kHz, its the number of waves produced.
Thus (a) is correct option.

28. By decreasing the amplitude of a pure note its :
(a) loudness decreases
(b) wavelength decreases
(c) quality changes
(d) speed decreases

Ans : COMP 2000

When the amplitude of vibration is large, the sound produced is loud. When the amplitude is small, the sound produced is feeble. Greater the amplitude, the greater is the loudness.
Thus (a) is correct option.

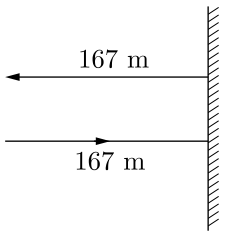
29. A person fires a gun in front of a building 167 m away. If the speed of sound is 334 ms^{-1}, calculate time in which he hears an echo.
(a) 2.0 sec (b) 1.0 sec
(c) 3.0 sec (d) 4.0 sec

Ans : MAIN 2003

According to the question,

$$d = 167$$

$$2d = 167 \times 2 \text{ m}$$



$$\text{Speed of sound} = 334 \text{ ms}^{-1}$$

$$\text{Time, } t = \frac{2d}{\text{speed}} = \frac{167 \times 2}{334}$$

$$= 1.0 \text{ second}$$

Thus (b) is correct option.

30. Which is not the condition for the formation of echoes ?
(a) The temperature of air should be above 20°C.
(b) The wavelength of sound should be less than the height of the reflecting body
(c) Minimum distance between the source of sound and reflecting body should be 17 m
(d) The intensity of sound should be sufficient so that it could be heard after reflection

Ans : SQP 2002

Downloaded from www.pdf.tube

20. The sound level at a point is increased by 30 dB. By what factor is the pressure amplitude increased?

(a) 16 times (b) 10 times
(c) 32 times (d) 8 times

Ans : MAIN 2005

The sound level in dB is

$$\beta = 10\log_{10}\left(\frac{I}{I_0}\right)$$

If β_1 and β_2 are the sound levels and I_1 and I_2 are the intensities in the two cases,

$$\beta_2 - \beta_1 = 10\left[\log_{10}\left(\frac{I_2}{I_0}\right) - \log_{10}\left(\frac{I_1}{I_0}\right)\right]$$

$$30 = 10\log_{10}\left(\frac{I_2}{I_1}\right) \text{ or } \frac{I_2}{I_1} = 10^3$$

As, the intensity is proportional to the square of the pressure amplitude, we have

$$\frac{P_2}{P_1} = \sqrt{\frac{I_2}{I_1}} = \sqrt{1000} = 32$$

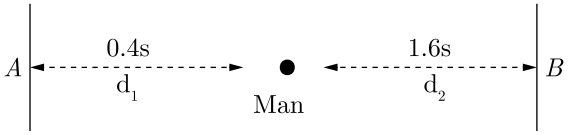
Thus (c) is correct option.

21. A man stands in between two high rise buildings and blows a whistle. He hears two successive echoes after 0.4 s and 1.6 s. Calculate the distance between buildings [Speed of sound = 332 ms^{-1}]

(a) 132 m (b) 332 m
(c) 232 m (d) 432 m

Ans : SQP 2022

Let the 2 buildings A and B situated at a distance d_1 and d_2 from a man's point.



$$t = 0.4 \text{ s}$$

$$d_2 = \frac{Vt}{2} = \frac{332 \times 1.6}{2}$$

$$d_2 = 265.6 \text{ m}$$

$$d_1 = \frac{Vt}{2} = \frac{332 \times 0.4}{2} = 66.4 \text{ m}$$

Hence, distance $AB = d_1 + d_2$

$$= 66.4 + 265.6 = 332.0 \text{ m}$$

Thus (b) is correct option.

22. Two notes are produced from a flute and piano, such that they have same loudness and same pitch. The notes so produced differ in their :

(a) speed (b) wavelength
(c) frequency (d) waveform

Ans : COMP 2015

A note's quality is determined by the waveforms. Because the waveforms are distinct and differ in quality or tone, two notes of the same pitch and loudness performed from various instruments do not sound the same.

The sounds from instruments are never pure notes, i.e. of one frequency, with the exception of a tuning fork, hence the same note from different instruments has distinct properties.

Thus (d) is correct option.

23. Water from a tap is allowed to fall in a vessel with a thin neck. The pitch of sound produced by falling water ..... with the volume of water in the vessel.

(a) increases (b) decreases
(c) remains same (d) none of these

Ans : SQP 2011

Water from a tap is allowed to fall in a vessel with a thin neck. The pitch of sound produced by falling water increases with the volume of water in the vessel

Thus (a) is correct option.

24. Name the machine seen in the figure using the principle of echo.

(a) sonography
(b) echo cardiogram
(c) intra venous machine
(d) electro cardiogram

Ans : MAIN 2019

An echocardiogram, or "echo", is a scan used to look at the heart and nearby blood vessels. It's a type of ultrasound scan, which means a small probe is used to send out high-frequency sound waves that create echoes when they bounce off different parts of the body.

Thus (b) is correct option.

NODIA

MULTIPLE CHOICE QUESTION

1. Two sound waves X and Y have the same amplitude and the same wave pattern but their frequencies are 60 Hz and 120 Hz respectively, then
(a) X will be shriller and Y will be grave
(b) X will be grave and Y will be shriller
(c) X will differ in quality than Y
(d) X is louder than Y.

Ans : SQP 2025

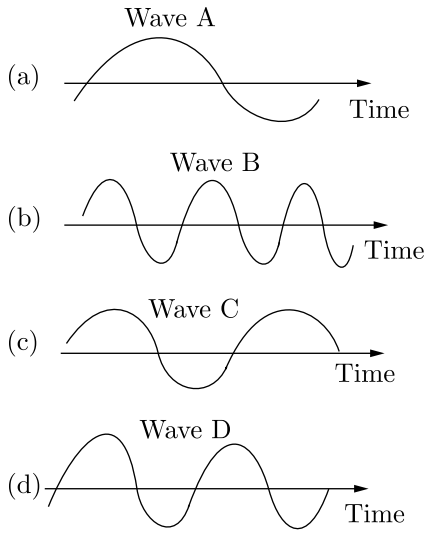
The shrillness of a sound wave is directly proportional to its frequency, meaning that higher frequencies result in shriller sounds and lower frequencies result in grave sound.
Thus (b) is correct option.

2. When the stem of vibrating tuning fork is pressed on a table, the tabletop starts vibrating. These vibrations are definitely an example of
(a) Resonance
(b) Natural vibrations
(c) Forced vibrations
(d) Damped vibrations

Ans : MAIN 2024

When stem of a vibrating tuning fork is pressed on a table, the table top starts vibrating due to the periodic force applied by the tuning fork. This is an example of forced vibration.
Thus (c) is correct option.

3. The diagram below shows four sound waves. Which sound has the highest pitch?



Ans : SEM-II 2022

As per given diagram wave B has the highest pitch due to more number of compressions and rarefactions per units time. The frequency of wave B is highest, hence wave B has the highest pitch.
Thus (b) is correct option.

4. Free vibrations are
(a) The vibrations under the influence of a periodic force
(b) The vibrations with larger amplitude
(c) The vibrations when the frequency continuously decreases
(d) The vibrations with a constant frequency and constant amplitude

Ans : SEM-II 2022

Free vibrations are the vibrations with a constant frequency and constant amplitude. It occurs when no external force acts on the body which causes the motion.
Thus (d) is correct option.

5. Which one of the following diagnostic methods use reflection of sound?
(a) CT scan
(b) Electrocardiogram
(c) Echocardiogram
(d) MRI

Ans : SEM-I 2021

Echo cardiogram is the diagnostic method which is based on reflection of sound using ultrasound.
Thus (c) is correct option.

6. Select a correct option with respect to echo depth sounding.
(a) Infrasonic waves are used.
(b) The frequency of the waves used is between 20 Hz and 20000 Hz.
(c) Ultrasonic waves are used.
(d) Supersonic waves are used.

Ans : SEM-I 2021

Ultrasonic waves are used to measure the distance, direction of underwater object and also to measure echo depth.
Thus (c) is correct option.

7. A boy standing in front of a wall produces two whistles per second. He notices that the sound of his whistling coincides with the echo. The echo is heard only once when whistling is stopped. Calculate the distance between the boy and the wall.
(The speed of sound in air = 320 m/s)

Click Here to Buy book on Amazon

Air temperature should be above does not come under the conditions for the formation of echoes
Thus (a) is correct option.

31. The sound produced by two tuning forks A and B have same amplitude and same waveform, but the frequency of A is three times more than B. In such a case :
(a) the note produced by A is shriller than B
(b) the note produced by B is shriller than A
(c) quality of sound of A differs from B
(d) the note produced by A has more speed than B.

Ans : COMP 2016

The tone A is high-pitched and the tone B is flat because the frequency A is higher than the frequency of B.
Thus (a) is correct option.

32. During night, distant sounds such as that of the traffic and the loudspeakers become louder than during day. This is due to
(a) absence of other sounds
(b) clear perception of hearing
(c) reflection of sound waves
(d) refraction of sound waves

Ans : MAIN 2019

Sound is louder at night due to change in direction of sound due to refraction. During night, sound bends towards the ground, whereas in day bends away from ground. Hence, at night ground starts releasing hear, hot air rises, the air closer to the ground is cooler. Hence, change of direction is caused by the reversal of temperature gradient from day to night.
Thus (d) is correct option.

33. An echo is heard by a radar in 0.08 s. If velocity of radio waves is 3×10^8 ms^{-1}, how far is the enemy plane ?
(a) 120 km (b) 1200 km
(c) 120000 km (d) 12000 km

Ans : COMP 2018

$$t = 0.08 \text{ s} \; ; \; v = 3 \times 10^8 \text{ ms}^{-1}$$

$$d = \frac{vt}{2}$$

$$= \frac{3 \times 10^8 \times 0.08}{2}$$

$$= \frac{3 \times 10^8}{2} \times \frac{8}{100}$$

$$= 12000000\text{m}$$

$$= \frac{12000000}{1000} = 12000\text{Km}$$

Thus (d) is correct option.

34. The practical application based on the reflection of sound is:
(a) megaphone (b) sounding board
(c) sonometer (d) both (a) and (b)

Ans : COMP 2015

Amplification of a person's voice is done by a portable megaphone. The megaphone is a cone-shaped acoustic horn. The person holds the smaller end of the horn near the mouth and the bigger end of the horn releases the louder sound. So option (a) is correct. Soundboard is the big concave board placed focusing on the speaker. The soundboard receives the sound from the speaker and reflects it towards the audience. This helps the audience to hear the sound very clearly even if they are away from the speaker. So option (b) is correct.
Thus (d) is correct option.

35. The frequency of a note with high pitch is greater than the frequency of a note with low pitch. Which statement about the note with the high pitch is not correct ?
I. It has larger wavelength.
II. It has smaller wavelength.
III. It has greater speed in air.
IV. It has lower speed in air.
(a) I, III and IV (b) Both III and IV
(c) I, II and IV (d) Both I and II

Ans : MAIN 2020

Statements I, III, IV are incorrect about note with high pitch. Pitch is the characteristics of sound by which we can distinguish between different sounds of the same loudness. High pitch sound corresponds to more number of compressions and rarefactions i.e., higher the pitch, higher is the frequency. As $v = \nu\lambda$, hence higher is the frequency lower will be the wavelength.
Thus (a) is correct option.

36. The voice of women is shrill as compared to men because of the difference in their :
(a) speed (b) frequency
(c) loudness (d) all these

Ans : SQP 2002

The shrillness or pitch of a sound is determined by its frequency. From above it is clear that the pitch of the female voice is higher than the pitch of the

Downloaded from www.pdf.tube

Given, $t = 0.8$ s, $d = 132.8$ m

$$\text{Speed} = \frac{2d}{t} = \frac{2 \times 132.8}{0.8}$$

$$= \frac{2656}{8} = 332 \text{ ms}^{-1}$$

Thus (d) is correct option.

ASSERTION AND REASON

49. **Assertion :** Waves produced in a cylinder containing a liquid by moving its piston back and forth are longitudinal waves.
Reason : In longitudinal waves, the particles of the medium oscillate parallel to the direction of propagation of the wave.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

When piston is moved back and forth, the molecules of the liquid also move along the direction of motion of the piston (direction of disturbance) also the volume and density of liquid is changing with motion of piston.
Thus (b) is correct option.

50. **Assertion :** The velocity of sound increases with increase in humidity.
Reason : Velocity of sound does not depend upon the medium.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

Velocity of sound increases with increase in humidity so it depends on the medium.
Thus (c) is correct option.

51. **Assertion :** Waves produced by a motor boat sailing in water are both longitudinal and transverse in nature.
Reason : The longitudinal and transverse waves cannot be produced simultaneously.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

The propeller of a motor boat cuts the water surface laterally and also pushes it is backward direction. Hence, it will result in both longitudinal and transverse waves.
Thus (c) is correct option.

52. **Assertion :** The flash of lightening is seen before the sound of thunder is heard.
Reason : Speed of sound is greater than speed of light.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

The speed of sound is 340 m/s and speed of light is 3×10^8 m/s in air. Thus flash of lightening is seen before the sound of thunder is heard.
Thus (c) is correct option.

53. **Assertion :** The velocity of sound changes as we go up in the atmosphere.
Reason : Pressure decreases as we go up in the atmosphere.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

As we move up the pressure of air, density of air, both decrease. But, velocity of sound will not change as long as temperature of air remains constant. Since temperature falls as we ascend up, hence the velocity of sound also decreases.
Thus (b) is correct option.

54. **Assertion :** Echo is produced when sound is incident on hard and polished surface.
Reason : Sound energy can be totally reflected by objects with soft and loose texture.

NODIA

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!

For cliff B, $v = 334\ \text{ms}^{-1}$

$$d_2 = \frac{vt}{2}$$

$$= \frac{334 \times 1.8}{2}$$

$$= 300.6$$

Distance between two cliffs

$$= d_1 + d_2$$

$$= 133.6 + 300.6 = 434.2\ \text{m}$$

Thus (a) is correct option.

42. A string is stretched between two nails fixed in the opposite walls and plucked from middle. The vibrations produced by the string are :

(a) forced vibrations (b) damped vibrations
(c) free vibrations (d) resonant vibrations

Ans : MAIN 2004

A string is stretched between two nails fixed on the opposite walls and plucked from the middle. The vibration produced by the string is free vibration.
Thus (c) is correct option.

43. The amplitude of a sound wave is increased from 1 mm to 2 mm. The loudness of the sound will :

(a) same (b) decrease
(c) increase two time (d) increase four times

Ans : SQP 2008

$$\text{Loudness} = (\text{amplitude})^2$$

So, if the amplitude is doubled then loudness will be 4 times.
Thus (d) is correct option.

44. An enemy plane is at a distance of 300 km from a radar. In how much time the radar will be able to detect the plane ? Take velocity of radio waves as 3×10^8 ms^{-1}.

(a) 4×10^{-3} s (b) 5×10^{-3} s
(c) 2×10^{-3} s (d) 3×10^{-3} s

Ans : COMP 2000

Given, $d = 300,\ t = ?$

$$v = 3 \times 10^8\ \text{ms}^{-1}$$

$$t = \frac{2d}{v} = \frac{2 \times 300 \times 1000\,\text{m}}{3 \times 10^8\,\text{ms}^{-1}}$$

$$= 0.002$$

$$= 2 \times 10^{-3}\,\text{second}$$

Thus (d) is correct option.

45. A tuning fork has a frequency of 212 Hz. It will produce resonance in a wooden board of frequency

(a) 212 Hz (b) 448 Hz
(c) 106 Hz (d) 318 Hz

Ans : MAIN 2007

The condition for the phenomenon of resonance is that the natural frequency of the given body (non-vibrating body), must be equal to the frequency of the vibrating body.

Here the wooden board is the non-vibrating body so the resonance in the wooden board will have the same frequency as the tuning fork.
The frequency in the wooden board will be 212 Hz
Thus (a) is correct option.

46. Sound waves of wavelength λ travelling in a medium with a speed of v m/s enter another medium, where its speed is 2 v m/s. What will be the wavelength sound waves in the second medium ?

(a) 2 λ (b) 4 λ
(c) λ (d) 3 λ

Ans : SQP 2008

Initially,sound wave has wavelength$= \lambda$

Now, speed $v = \nu\lambda$ ...(i)

where, v is the frequency of sound wave.
Now, in another medium, let the speed $= 2v$

Then, $v_1 = 2v = \nu\lambda_1$ ...(ii)

On dividing Eq. (ii) by Eq. (i), we get

$$\frac{v_1}{v} = \frac{2v}{v} = \frac{\nu\lambda_1}{\nu\lambda}$$

$$\lambda_1 = 2\lambda$$

Thus (a) is correct option.

47. The amplitude of forced vibrations is generally ..... than the amplitude of applied external force.

(a) more (b) equal to
(c) less (d) none of these

Ans : SQP 2015

The amplitude of forced vibration is generally less than vibrations of external force.
Thus (c) is correct option.

48. An echo is heard after 0.8 s, when a person fires a cracker, 132.8 m from a high building. Calculate the speed of sound.

(a) 632 ms^{-1} (b) 432 ms^{-1}
(c) 532 ms^{-1} (d) 332 ms^{-1}

Ans : COMP 2014

Click Here to Buy book on Amazon

59. What is meant by noise pollution? Name one source of sound causing noise pollution.

Ans : SQP 2016

Unpleasant sounds are called noise. Some of the main 'noise polluters' are aircraft, road traffic and greatly amplified music.

60. Name the subjective property of sound related to its frequency and of light related to its wavelength.

Ans : MAIN 2010

The subjective property of sound waves, related to its frequency, is known as its pitch.
The name of the similar subjective property of light, related to its wavelength, is the colour of light.

61. Explain why echoes can't be heard in a small room.

Ans : COMP 2008

For hearing echo, there should be atleast a distance of 17 m between the source of sound and the body from which sound is reflected. In small rooms this is not the case, hence echoes are not heard.

62. How do you account for the fact that two strings can be used to give notes of the same pitch and loudness but of different quality?

Ans : SQP 2005

The quality of a given note is determined by the overall effect of the harmonics (multiples of the fundamental frequency) present in it. Due to which the waveform of the two notes be different or note produced of same pitch and loudness will be of different quality.

63. Two tuning forks A and B of same frequencies are placed on two boxes in adjoining positions. 'liming fork A is set into vibrations. What would be your observation?

Ans : COMP 2003

Vibrations of A cause the air in the other box to vibrate which in turn set the tuning fork B (frequency same as of A) to vibrate, therefore resonance takes place.

64. Why does the amplitude of a vibrating body continuously decrease during damped vibrations?

Ans : MAIN 2018

Energy is used up in overcoming friction.

65. A tuning fork has two prongs. Why?

Ans : SQP 2002

The two prongs of a tuning fork set each other in resonant vibrations which help to maintain the vibrations for a longer time.

66. If the amplitude of a wave is doubled, what will be the effect on its loudness ?

Ans : MAIN 2000

Loudness depends upon the square of the amplitude of the wave, therefore, when the amplitude of wave is doubled the loudness becomes four times.

67. Name the system which enables us to locate underwater objects by transmitting ultrasonic waves and detecting the reflecting impulse.

Ans : SQP 2020

SONAR.

68. What are acoustically measurable quantities related to pitch and loudness?

Ans : COMP 2020

Frequency and intensity of sound.

69. What do you understand by free vibrations of a body?

Ans : SQP 2018

If a body vibrates with its own frequency it is called a free vibration.

70. What is an echo ?

Ans : COMP 2016

An echo is the phenomenon of repetition of sound of a source by reflection from an obstacle.

71. State two conditions for an echo to take place.

Ans : MAIN 2016

Presence of a solid reflecting material and the distance between the obstacle and the source of sound should be such that it takes the reflected sound at least 0.1 s to reach the source.

72. Draw a graph between displacement and the time for a body executing free vibrations.

Ans : SQP 2015

NODIA
FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

Sound energy gets partially absorbed by objects with soft and loose texture.
Thus (c) is correct option.

55. **Assertion :** The longitudinal waves are called pressure waves.
Reason : Propagation of longitudinal waves through a medium involves changes in pressure and volume of air, when compression and rarefaction are formed.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

In longitudinal wave, pressure variations travel along the tube with the density variations, when the density reaches its maximum at a particular location, the pressure also reaches its maximum at that location.
Thus (a) is correct option.

56. **Assertion :** Two persons on the surface of moon cannot talk to each other.
Reason : There is no atmosphere on the moon.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :.

Sound waves require material medium to travel. As there is no atmosphere (vacuum) on the surface of moon therefore the sound waves cannot travel from one person to another. Because of this reason, for communication on moon astronomer use phones, which convert sound wave into radio waves (electromagnetic waves which need no medium for propagation).
Thus (a) is correct option.

57. **Assertion :** A vibrating tuning fork sounds louder when its stem is pressed against a desktop.
Reason : When a wave reaches another denser medium, part of the wave is reflected.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Ans :

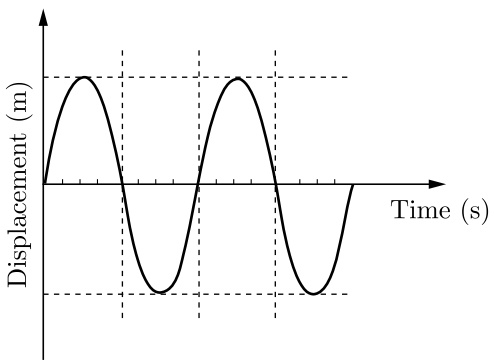
If the tuning fork is held in hand and hit with hammer, a sound is produced as the prongs of the tuning fork set surrounding air particles into vibrational motion. The sound produced by the tuning fork in air is barely audible. However, if the tuning fork is set on a desktop. The desktop begins vibrating at the same natural frequency of the tuning fork. The tuning fork forces surrounding desktop particles into vibrational motion. The vibrating desktop in turn forces surrounding air particles into vibrational motion. As the surface area of desktop is greater than the surface area of tuning fork, more surrounding air particles will be forced into vibration. This causes an increase in the amplitude and thus loudness of the sound.
Thus (c) is correct option.

ONE MARK QUESTIONS

58. Draw a graph between displacement from the mean position and time for a body executing free vibration in a vacuum.

Ans : COMP 2020

The graph is as shown :



Downloaded from www.pdf.tube

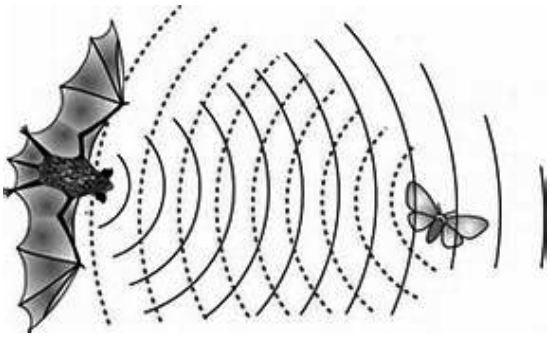
male voice, therefore a woman's voice is shriller than a man's voice, due to higher frequency.
Thus (b) is correct option.

37. To locate its prey in the darkness the owl or the bat emits:
(a) ultrasonic waves (b) infrasonic waves
(c) sonic waves (d) infrared waves

Ans : MAIN 2005

To locate its prey in the darkness the owl or the bat emits ultrasonic waves.
Thus (a) is correct option.

38. Bats use this technique to detect their prey and hunt them.



(a) flapping their wings
(b) reflection of sound waves
(c) echo
(d) both (b) and (c)

Ans : COMP 2016

Thus (d) is correct option.

39. The speed of sound is 310 ms^{-1}. A person fires a gun. An echo is heard after 1.5 s. Calculate the distance of person from the cliff from which echo is heard.
(a) 132.5 m (b) 332.5 m
(c) 232.5 m (d) 432.5 m

Ans : MAIN 2014

Given,

$$\text{Speed of sound} = 310 \text{ ms}^{-1}$$

Time after which echo is heard,

$$t = 1.5 \text{ s}$$

$$2d = \text{Speed} \times t$$

$$d = \frac{310 \times 1.5}{2}$$

$$= 232.5 \text{ m}$$

Thus (c) is correct option.

40. The pressure amplitude in sound wave from a radio receiver is 2.0×10^{-2} N/m^2 and the intensity at a point is 5.0×10^{-7} N/m^2. If by turning the volume knob, then the pressure amplitude increased to 2.5×10^{-2} N/m^2. Evaluate the intensity.
(a) 7.8×10^{-7} W/m^2 (b) 7.8×10^{-6} W/m^2
(c) 7.8×10^{-8} W/m^2 (d) 7.8 W/m^2

Ans : MAIN 2022

As we know that,

$$I = \frac{p^2}{2\rho v}$$

Where, p = pressure amplitude,

I = intensity, ρ = density

and v = velocity

i.e., $I \propto p^2$

$$\frac{I_1}{I_2} = \frac{p_1^2}{p_2^2}$$

$$I_2 = \frac{p_2^2}{p_1^2} \cdot I_1$$

$$= \frac{2.5 \times 10^{-2} \times 2.5 \times 10^{-2} \times 5 \times 10^{-7}}{2 \times 10^{-2} \times 2 \times 10^{-2} \times 100}$$

$$= \frac{25 \times 25}{80} \times 10^{-7}$$

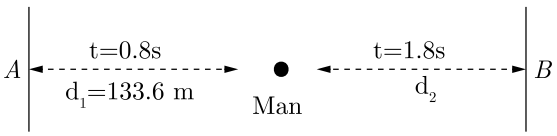
$$= \frac{625}{80} \times 10^{-7}$$

$$= 7.8 \times 10^{-7} \text{ W/m}^2$$

Thus (a) is correct option.

41. A man stands in between two cliffs, such that he is at a distance of 133.6 m from nearer cliff. He fires a gun and hears first echo after 0.8 s and second echo after 1.8 s. The distance between two cliffs is
(a) 434.2 m (b) 234.2 m
(c) 334.2 m (d) 134.2 m

Ans : COMP 2021



For nearer cliff A, $t = 0.8$ s, $t = 1.8$ s

$$d_1 = 133.6 \text{ m}$$

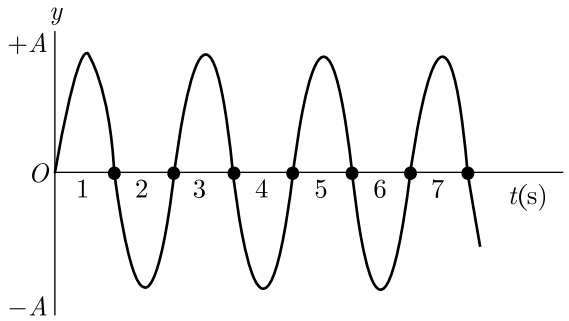
$$\text{Speed of sound } v = \frac{2d_1}{t}$$

$$v = \frac{2 \times 133.6}{0.8}$$

$$= 334 \text{ ms}^{-1}$$

NODIA

The graph is as shown :



73. Where can a body execute free vibrations?

Ans : COMP 2015

In vacuum.

74. What are mechanical waves?

Ans : MAIN 2014

Mechanical waves are those waves, which require material medium for their propagation.

75. Name one property of waves that do not change when the wave passes from one medium to another.

Ans : SQP 2014

When a wave passes from one medium to another, its frequency does not change.

76. Name the waves used for echo depth sounding.

Ans : MAIN 2016

Ultrasonic.

77. Give one reason for their use for the above purpose.

Ans : COMP 2016

Easier to transmit through water

78. Why are the waves mentioned by you not audible to us ?

Ans : SQP 2016

Because their frequency is greater than 20 kHz the upper limit of our audible range.

79. Name the type of waves which are used for sound ranging.

Ans : COMP 2011

Ultrasonic waves are used for sound ranging.

80. Why are these waves mentioned in (a) above, not audible to us ?

Ans : SQP 2011

The frequency of ultrasonic waves is above 20000 Hz which is beyond the audibility range of humans.

81. Give one use of sound ranging.

Ans : COMP 2011

Sound ranging is used for finding the depth of sea.

82. Suggest one way by which the rattling sound could be stopped.

Ans : SQP 2008

To stop these vibrations, the speed of vehicle is changed, so that the condition of resonance will not then hold.

83. What are damped vibration ?

Ans : COMP 2017

Those vibrations which die out with time.

84. Give one example of damped vibrations.

Ans : MAIN 2017

Vibrations of a simple pendulum.

85. Name the phenomenon that causes a loud sound when the stem of a vibrating tuning fork is kept pressed on the surface of a table.

Ans : SQP 2017

Resonance.

86. What is an echo?

Ans : COMP 2016

Echo is the sound heard after reflection from a large obstacle such as high buildings etc. after the original sound from the given source dies off.

87. A man playing a flute is able to produce notes of different frequencies. If he closes the holes near his mouth, will the pitch of the note produced, increase or decrease? Give a reason.

Ans : SQP 2019

The pitch will decrease, as the pitch is inversely proportional to the length of the vibrating air column.

Download NODIA App for All Sample Papers PDFs

Click Here to Buy book on Amazon

106. State two differences between light waves and sound waves.

Ans : MAIN 2002

The two main differences between light and sound waves are :

	Light waves	Sound waves
1.	They are electromagnetic waves and their velocity is 3×10^8 ms^{-1}.	These are mechanical waves and their velocity is 340 ms^{-1}.
2.	They have very small wavelength.	The wavelength of sound waves is quite large compared with that of light.

107. Two waves of the same pitch have their amplitudes in the ratio 2 : 3.
(i) What will be the ratio of their loudness ?
(ii) What will be the ratio of their frequencies ?

Ans : SQP 2010

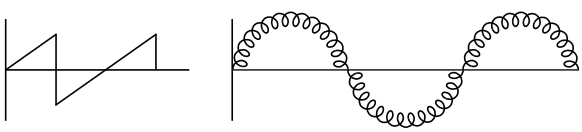
(i) Since loudness is proportional to the square of the amplitude, therefore, loudness will be in ratio of $(2)^2 : (3)^2$ i.e., 4 : 9.
(ii) Since their pitch is the same, therefore, their frequencies will be the same i.e., their ratio is 1 : 1.

108. Two waves of the same pitch have amplitudes in the ratio 1: 3.
What will be the ratio of their:
(i) intensities and
(ii) frequencies?

Ans : COMP 2019

(i) Ratio of intensities will be 1 : 9.
(ii) Ratio of frequencies will be 1 : 1.

109. Two musical notes of same pitch and loudness are played on a violin and a piano. The waveforms are as shown in figures below. Explain why the wave patterns are different.



Violin Piano

Ans : SQP 2020

The number and nature of harmonics and overtones present, affects the quality of the sound. The different combinations of the number and nature of harmonics and overtones present in the 'notes' give these different wave patterns.

110. How does frequency and amplitude affect a musical sound?

Ans : COMP 2015

The frequency of musical sound affects its 'pitch'. The more the frequency of a sound, the sharper and shriller it becomes. A lower frequency makes the sound flatter. The amplitude of musical sound affects its loudness; more the amplitude of the sound, louder the sound.

111. What is meant by the 'loudness' of a sound? How is it related to the intensity?

Ans : MAIN 2019

Loudness is an aural sensation, i.e., a physiological rather than a physical phenomenon. It increases with intensity but the relation between the two is not linear, i.e., the ear does not recognise a sound, having twice the intensity of another, as twice as loud. In fact loudness (L) of a sound and its intensity (I) are related as $L = k \log (I/I_0)$, here I/I_0 is the intensity level of the sound or the ratio between its intensity I and the zero of intensity or the threshold intensity I_0 and k is a constant of proportionality depending upon the unit chosen.

112. Bats can ascertain distances, directions, nature and size of the obstacle without eyes. Explain how.

Ans : SQP 2002

Bats emit ultrasonic waves of large frequencies which are reflected from the obstacle in their path and give the idea about the distance, direction, size and nature of the obstacle.

113. Write the factors on which intensity of sound depends.

Ans : COMP 2010

Intensity of sound depends on the following factors. Intensity of sound is
(i) Amplitude
(ii) Distance between source and observer.
(iii) Density of medium
(iv) Surface are of vibrating body.
(v) Frequency of the source.

NODIA

On being set into vibrations, the stretched string, forces the surrounding air to vibrate. This vibrating air, in turn, affects our ear drum and produces an audible sound.

98. State two ways by which the frequency of transverse vibrations of a stretched string can be increased.

Ans : COMP 2016

The frequency of transverse vibrations of a stretched string can be increased by

(i) decreasing the length of the stretched string as frequency $n \propto \frac{1}{l}$ when tension T and mass per unit length of the wire, m are kept constant.

(ii) increasing the tension T in the string as $n \propto \sqrt{T}$ where length, l and mass per unit length of the wire are kept constant.

99. What is meant by noise pollution? Name one source of sound causing noise pollution.

Ans : MAIN 2016

Noise pollution is displeasing human, animal or machine created sound (of level above 120 dB) that disrupts the activity or balance of human/animal life, i.e. cause headache, permanent damage to the ears, etc.

One source of sound causing noise pollution may be aeroplanes/heavy vehicles/heavy machines/music system/dynamite/siren, etc.

100. State one important property of waves used for echo depth sounding.

Ans : SQP 2014

The waves used for echo depth sounding are ultrasonic waves (frequency above 20000 Hz). The important property of such type of a wave is that they travel undeviated through long distances and that they can be confined to a narrow beam. They are not easily absorbed in a medium.

101. What is meant by resonance?

Ans : COMP 2012

It is the phenomenon in which body vibrates under the influence of periodic force where frequency of the applied periodic force is equal to the natural frequency of the vibrating body. In this case the body begins to vibrate with increased amplitude.

102. State two ways in which resonance differs from forced vibrations.

Ans : MAIN 2012

Differences between resonance and forced vibrations are as follows :

	Resonance	**Forced vibrations**
(i)	Amplitude of vibrations becomes large.	Amplitude of vibrations decreases.
(ii)	It is the phenomenon of setting a body (X) into vibration with the help of another body (Y) where frequency of (Y) is equal to the natural frequency of (X).	In forced vibrations a body (X) is set into vibrations under the influence of periodic force of body (Y). Frequency of vibration of body (Y) is different from the natural frequency of body (X).

103. When acoustic resonance takes place, a loud sound is heard. Why does this happen? Explain.

Ans : SQP 2011

When acoustic resonance takes place then amplitude of sound is increased. As loudness of sound is directly proportional to the square of amplitude ($L \propto A^2$) therefore, loudness of sound increases.

104. Three musical instruments give out notes at the frequencies listed below.

Flute: 400 Hz; Guitar: 200 Hz; Trumpet: 500 Hz.

(i) Which one of these has the highest pitch?

(ii) With which of the following frequencies does a tuning fork of 256 Hz resonate?
288 Hz, 314 Hz, 333 Hz, 512 Hz.

Ans : COMP 2011

(i) Trumpet has the highest pitch, i.e. 500 Hz.

(ii) 512 Hz as 512 is an integral multiple of the natural frequency of the tuning fork.

105. When a tuning fork [vibrating] is held close to ear, one hears a faint hum. The same [vibrating tuning fork] is held such that its stem is in contact with the table surface, then one hears a loud sound. Explain.

Ans : MAIN 2020

This is due to the phenomenon of resonance, the table also begins to vibrate with the same frequency as that of the tuning fork and produces large sound.

NODIA

TWO MARKS QUESTIONS

88. (a) Name the waves used for echo depth sounding.
(b) Give one reason for their use in the above purpose.

Ans : SQP 2025

(a) ultrasonic waves
(b) they travel long distance without deviation / not easily absorbed by the medium OR can be confined to a narrow beam.

89. Rohan conducted experiments on echo in different media. He observed that a minimum distance of 'x' metres is required for the echo to be heard in oxygen and 'y' metres in benzene. Compare 'x' and 'y'. Justify your answer.

Ans : MAIN 2024

Applying the formula

$$d = v \times \frac{0.1}{2}$$

For Oxygen, $x = 340 \times \frac{0.1}{2} = 17\text{ m}$

For Benzene, $y = 200 \times \frac{0.1}{2} = 10\text{ m}$

So, x : y = 17 : 10

90. State two conditions for an echo to take place.

Ans : MAIN 2016

(i) The size of the obstacle/reflector must be large compared to the wavelength of the incident sound.
(ii) The minimum distance between the source of sound and the reflector should be at least 17 m.

91. It is observed that during march-past we hear a base drum distinctly from a distance compared to the side drums.
(i) Name the characteristic of sound associated with the above observation.
(ii) Give a reason for the above observation.

Ans : COMP 2019

(i) Intensity of sound.
(ii) This is because the amplitude of vibration of a base drum is far greater than the amplitude of vibration of the side drum.

92. How is the frequency of a stretched string related to:
(i) its length ?
(ii) its tension ?

Ans : MAIN 2017

(i) Inversely proportional to its length and
(ii) Directly proportional to the square root of tension.

93. State two ways by which the frequency of transverse vibrations of a stretched string can be increased.

Ans : SQP 2016

(i) By increasing the tension in the string and
(ii) Decreasing the length of the string.

94. A bucket kept under a running tap is getting filled with water. A person sitting at a distance is able to get an idea when the bucket is about to be filled.
(i) What change takes place in the sound to give this idea ?
(ii) What causes the change in the sound ?

Ans : COMP 2013

(i) As the water level in the bucket increases, length of air column decreases, frequency increases so the sound becomes shriller and a person can get an idea of bucket to be filled.
(ii) Due to change in length of air column, frequency changes.

95. Name the subjective property of
(a) sound related to its frequency.
(b) light related to its wavelength.

Ans : SQP 2010

The subjective property of :
(a) sound related to its frequency is pitch (or shrillness).
(b) light related to its wavelength is colour.

96. Will the sound be audible if the string is set into vibration on the surface of the moon?
Give reason for your answer.

Ans : MAIN 2001

No, we will not hear any audible sound on the surface of the moon. This is because sound requires a medium to propagate. Since, there is no atmosphere on the surface of the moon, therefore, the sound will not be heard.

97. How does a stretched string on being set into vibration, produce the audible sound ?

Ans : SQP 2001

Downloaded from www.pdf.tube

114. Sometime when a vehicle is driven at a particular speed, a rattling sound is heard. Explain briefly, why this happens and give the name of the phenomenon taking place.

Ans : MAIN 2016

The frequency of movement of piston in the engine becomes equal to the natural frequency of the part which is rattling.
Resonance.

115. Write the factors on which the frequency of a stretched string depends.

Ans : SQP 2002

Frequency of the note emitted by stretched string depends on the following factors:

(i) length of the stretched string, i.e. $n \propto \frac{1}{l}$ when T and m are constants.

(ii) tension in the string, i.e. $n \propto \sqrt{T}$ when l and m are constants

(iii) mass per unit length of the string, i.e. $n \propto \frac{1}{\sqrt{m}}$ when l and T are constants.

116. Give one example each of natural vibration, forced vibration and resonance.

Ans : COMP 2018

Natural vibration : When tuning fork is gently struck against a rubber pad.
Forced vibration : When the string of a musical instrument is plucked, it forces the sounding board to vibrate with the frequency of the string.
Resonance : While tuning a wireless receiver, natural frequency of the receiver set is adjusted equal to that of the incoming carrier wave, a loud sound of incoming signal is heard.

117. Why an echo is not heard when distance between source of sound and reflecting body is 10 m?

Ans : MAIN 2021

The sensation of any sound persists in our ear for about 0.1 s after the sound heard dies off. If the echo is heard within this time interval the original sound and the echo cannot be distinguished. So, to hear the echo distinctly, the minimum distance of the obstacle from the observer should be 17 m.

118. How is the sound wave produced in strings fixed at both ends?

Ans : SQP 2020

When a string stretched between two fixed points is bowed, struck or plucked, transverse vibrations travel along the string, these are reflected at the fixed ends and a standing wave pattern is formed. The vibrations of the string give rise to longitudinal waves in air which is transmitted to our ear.

119. Write the frequency range of infrasonic, audible and ultrasonic waves.

Ans : SQP 2003

Frequency range for infrasound	– below 20 Hz
audible sound	– 20 Hz to 20000 Hz
ultrasound	– above 20000 Hz

NODIA

120. How do trawler-men locate shoals of fish in high sea?

Ans : COMP 2003

Trawler-men send ultrasonic beam into water from ultrasonic vibrators fitted in trawler which strike fish and reflect back. Reflected beams are picked up by special receivers on the trawler. Thus, the position of the shoals of fish is determined by the use of echo method and by using the formula

$$d = \frac{\nu \times t}{2}$$

where, ν is the velocity of sound in water.

121. Two friends were playing on identical guitars whose strings were adjusted to give notes of the same pitch. Will the quality of the two notes be the same? Give a reason for your answer.

Ans : MAIN 2005

No, because both the guitars emit same fundamental note but subsidiary notes will not be exactly same due to which the waveform of the two guitars will be different so they will differ in quality.

122. Define pitch of a note. What are the factors upon which pitch of a note depends?

Ans : SQP 2021

Pitch of a note is that subjective property which distinguishes a sharp sound from a dull sound. Pitch depends on an objective quantity frequency of the source (ν), i.e., the pitch of a musical note is said to be large if its frequency is large while the pitch is said to be small if its frequency is small.

$$n = \frac{p}{2l}\sqrt{\frac{T}{m}}$$

where $p = 1, 2, 3, ...$

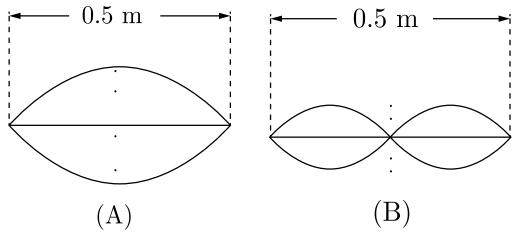
If the frequencies given out are the integral multiple of the fundamental frequency and are called overtones excluding the fundamental and harmonics if the fundamental is included.

171. A stretched wire 0.5 m long is made to vibrate in two different modes as shown in diagram (A) and (B) given below

(i) If the wavelength of the wave produced in mode (A) is 1 m, what is the wavelength of the wave produced in mode (B) of the following diagram?

(ii) In which case is the note produced louder? Give a reason for your answer.

(iii) In which case is the pitch of the note produced higher ? Give a reason for your answer.



Ans : COMP 2017

(i) The wavelength of the wave produced in mode B is half of that in mode A.

(ii) The note produced in mode A is louder. This is because the amplitude of the wave in mode A is more than that of mode B. Loudness, being proportional to the square of the amplitude, would, therefore, be more in mode A.

(iii) The pitch of the note produced in mode B is higher. This is because pitch becomes higher with an increase in frequency. As seen from the figure, the frequency of note in mode B is twice as much as that of the note in mode A.

172. What is meant by the 'pitch' of a note? Does it depend on the loudness or 'quality' of the 'note'? How is pitch 'related' with frequency?

Ans : MAIN 2002

The pitch of a note is determined solely by its frequency. The pitch in fact, is a subjective sensation in the ear depending only upon the frequency of the musical sound and is quite independent of its loudness or quality. Pitch is thus, a subjective phenomenon and cannot be physically measured. However, the relation between pitch and frequency is linear to a very close approximation. Hence, pitch is usually taken to be synonymous with frequency. Generally, notes of high frequency or pitch are shrill and sharp whereas those of low frequency or pitch are flat and dull.

173. State the steps to control the noise pollution.

Ans : SQP 2008

There are three steps to control the noise pollution:

(i) Elimination of the noise at source:
This can be done by using elastic suspension, new design of machine, proper oiling, greasing and maintenance of devices, etc.

(ii) Modification of the path:
The plantation increases distance between source of sound and receiver.

(iii) Protection to receiver using ear plug.

174. (a) A person is tuning his radio set to a particular station. What is the person trying to do to tune it?

(b) Name the phenomenon involved, in tuning the radio set.

(c) Define the phenomenon named by you in part(b).

Ans : MAIN 2003

(a) A person is trying to match the frequency of his radio set with the frequency of the radio waves transmitted by the broadcasting station.

(b) Resonance.

(c) Resonance is the phenomenon in which body vibrates under the influence of periodic force where frequency of the applied periodic force is equal to the natural frequency of the vibrating body. In this case the body begins to vibrate with increased amplitude.

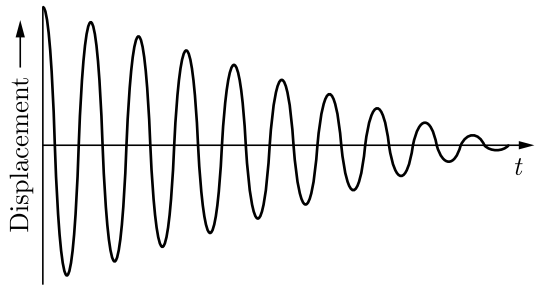
175. What do you mean by musical sound and noise? Give two examples of each. Also represent musical sound and noise graphically.

Ans : SQP 2020

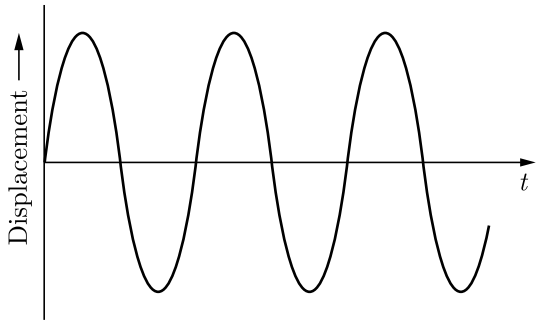
Musical sound is a pleasant, continuous and uniform sound produced by regular and periodic vibrations, e.g. sound produced by a violin, flute, tuning fork, piano, etc. Noise is harsh, unpleasant sound produced by an irregular succession of disturbances and is discontinuous, e.g. sound produced by a gunshot, cracker bomb, hammer blow, etc.

Click Here to Buy book on Amazon

of a vibrating body are called damped vibrations, e.g. a simple pendulum oscillating in air.



Damped vibrations

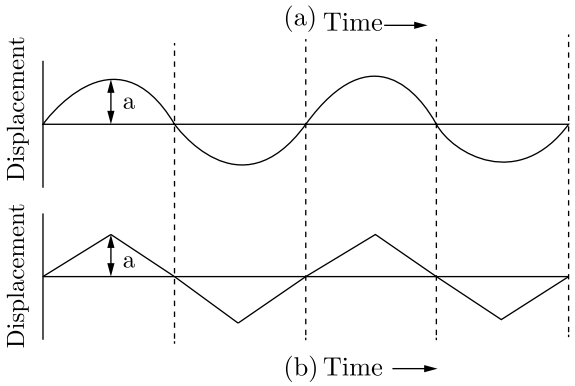


Free vibrations

130. What do you mean by the term quality? Illustrate your answer with a diagram.

Ans : COMP 2013

Quality or timbre of a musical sound is that subjective characteristic which enables us to distinguish between two sounds of the same loudness and the same pitch but emitted by two different sources.



131. What happens to the amplitude of the vibrations of a body undergoing (a) forced vibrations and (b) resonance?

Ans : MAIN 2002

In case of forced vibrations, the body vibrates with a constant but generally of a small amplitude while in case of resonance, body vibrates in the same phase with force, at any instant, therefore, body vibrates with a large amplitude and a loud sound is heard.

132. Explain the conditions under which resonance occurs. State one example of a phenomenon based on resonance.

Ans : SQP 2015

Resonance is the special case of forced vibrations where frequency of the applied periodic force is equal to the natural frequency of the vibrating body. In this case the body begins to vibrate with increased amplitude.

If the natural frequency of a building becomes equal to the frequency of periodic oscillations generated in earth during an earthquake, the building will start oscillating with large amplitude. Thus, the building may collapse ultimately.

133. What is SONAR? State the principle on which it is based.

Ans : COMP 2000

SONAR is an abbreviation for Sound Navigation and Ranging. This instrument uses ultrasonic waves (frequency $>$ 20000 Hz) to detect and locate objects under water, e.g. submerged rocks, submarines, etc. Wave from a transmitter is sent towards the distant object and its echo, i.e. reflected wave is received back; knowing the time t between the instant the ultrasonics are transmitted and received, the distance d of the object is calculated by the relation

$$d = \frac{v \times t}{2}$$

where v is the velocity of the ultrasonics.

134. Explain with example the meaning of free or natural vibrations. Also state the cause of vibrations.

Ans : MAIN 2006

When a simple pendulum is displaced slightly from its mean position and released, it begins to perform vibrations which are known as free or natural vibrations. The frequency with which the body vibrates is known as its natural frequency. These vibrations arise due to restoring forces set up by the body internally.

NODIA

tuning fork $E = 320$ Hz.

(ii) B produces louder sound due to the condition which is known as resonance.
In resonance, when the frequency of an externally applied periodic force on a body is equal to its natural frequency, the body readily begins to vibrate with an increased amplitude.

161. Vibrating tuning fork is placed over the mouth of a burette filled with water. The tap is opened and the water level gradually falls. It is observed that the sound becomes the loudest for particular length of air column :
(i) What is the name of the phenomenon taking place when this happens?
(ii) Why does the sound become the loudest?
(iii) What is the name of the phenomenon taking place when sound is produced for another length of air column and is not the loudest ?

Ans : COMP 2002

(i) When the sound becomes loudest, the name of the phenomenon taking place is resonance. This is called the fundamental mode of vibration.
(ii) The sound becomes loudest for a particular length of air column because the natural frequency, of this length of air column becomes equal to the frequency of the vibrating tuning fork.
(iii) For another length of air column (nearly three times the first length), we again get sound produced but it is not the loudest. We are then again having resonance but this corresponds to the first harmonic mode of vibration of the air column.

162. The rear view mirror of motor bike starts vibrating violently at some particular speed of motor bike.
(a) Why does this happen?
(b) What is the name of the phenomenon taking place ?
(c) What could be done to stop the violent vibrations?

Ans : MAIN 2000

(a) This happens when the frequency of vibration of the motorcycle engine becomes equal to the natural frequency of the rear view mirror.
(b) This phenomenon is called resonance.
(c) The motor bike driver should change his speed. That would make the frequency of vibration of the motorcycle engine different from the natural frequency of the rear view mirror and resonance will no longer take place.

163. (i) Name the type of waves which are used for sound ranging.
(ii) Why are these waves mentioned in (i) above, not audible to us?
(iii) Give one use of sound ranging.

Ans : SQP 2011

(i) Ultrasonic waves.
(ii) Because their frequency lies beyond the limits of audibility (20 Hz – 20,000 Hz).
(iii) To locate the position of the object under water and to find the depth of sea.

164. (a) Name the characteristic of sound which enables a person to differentiate between two sounds with equal loudness but having different frequencies.
(b) Define the characteristic named by you in (a).
(c) Name the characteristic of sound which enables a person to differentiate between two sounds of the same loudness and frequency but produced by different instruments.

Ans : COMP 2013

(a) Pitch.
(b) Pitch of a sound is that subjective property which distinguishes a sharp sound from a dull sound.
(c) Quality or timbre.

165. (a) Sound made in front of a tall building 18 m away, is repeated. Name the phenomenon and briefly explain it.
(b) A tuning fork, held over an air column of a given length, produces a distinct audible sound. What do you call this phenomenon? How does it occur?

Ans : MAIN 2002

(a) Echo is the sound heard after reflection from a large obstacle such as tall building when the original sound from the given source died away off. Echo is formed if the reflected sound is heard after 0.1 s (persistence of hearing) from a large obstacle (size of the obstacle compared to the wavelength of the incident sound). The minimum distance between the source of sound and the reflector should be at least 17 m $\left(d = \frac{340\ \text{m/s} \times 0.1\ \text{s}}{2}\right)$.

Here in this question it is and the reflector

Downloaded from www.pdf.tube

143. A vibrating tuning fork is placed over the mouth of a burette filled with water. The tap of the burette is opened and the water level gradually starts falling. It is found that the sound from the tuning fork becomes very loud for a particular length of the water column.
(i) Name the phenomenon taking place when this happens.
(ii) Why does the sound become very loud for this length of the water column ?

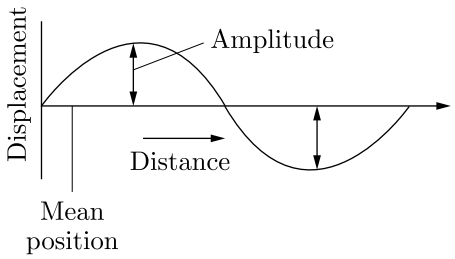
Ans : MAIN 2013

(i) Resonance.
(ii) When the frequency of air column becomes equal to the frequency of tuning fork i.e., vibrations of air column are in resonance with those of fork, loud sound is heard.

144. What is meant by the term (1) amplitude, (2) frequency of a wave ?

Ans : SQP 2013

(i) (1) Maximum displacement of wave from its mean position on either side is known as amplitude.



(2) Number of vibrations produced in 1 second is frequency.

145. Explain why stringed musical instruments, like the guitar are provided with a hollow box.

Ans : COMP 2013

A vibrating string by itself produces a very weak sound which cannot be heard at a distance. Therefore, all stringed instruments are provided with sound boxes having air inside. So when string vibrates the air inside sets into forced vibrations which have same frequency. Due to large air column and resonance loud sound is heard.

146. Which characteristic of sound will change if there is a change in
(i) its amplitude
(ii) its waveform.

Ans : MAIN 2012

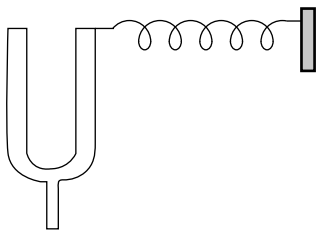
(i) Loudness
(ii) Quality or timbre

147. (i) Name one factor which affects the frequency of sound emitted due to vibrations in an air column.
(ii) Name the unit used for measuring the sound level.

Ans : SQP 2012

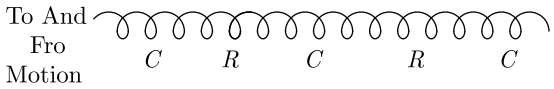
(i) Frequency of sound emitted due to vibrations in an air column is affected by the length of air column.
(ii) Unit used for measuring the sound level is decibel (dB).

148. The figure below shows a tuning fork with one of its prongs fastened to one end of a spring whose other end is fastened to a rigid support. When the tuning fork is made to vibrate, how does the pattern of the coils of the spring change ?



Ans : COMP 2016

When the tuning fork is made to vibrate, then the wave pattern of the spring becomes.



149. Why are soldiers asked to walk out of step while crossing bridges?

Ans : MAIN 2002

When the soldiers walk in step, they produce some fixed frequency. If this frequency corresponds to the natural frequency of the bridge, resonance can takes place. This will make the bridge vibrate violently and hence it may collapse. To avoid such a situation, the soldiers are asked not to march in step.

150. Why does a wine glass start rattling, when a note of some particular frequency is struck by a piano?

Ans : SQP 2008

When the glass rattles, at that moment, its

NODIA

natural frequency corresponds with the frequency with which the piano is being played. Thus, resonance takes place, which makes the glass to vibrate violently.

151. Why does rear view mirror of a motor bike start vibrating violently, at some particular speed of motor bike?

Ans : COMP 2021

When the frequency of the engine of motor bike corresponds with the natural frequency of rear view mirror, resonance takes place. Thus, rear view mirror vibrates with larger amplitude.

152. A tuning fork (vibrating) is held close to ear. One hears a faint hum. The same (vibrating) tuning fork is placed on table, such that its handle is in contact with table, one hears a loud sound. Explain.

Ans : MAIN 2023

A tuning fork held close to ear, disturbs a small amount of air and hence sound heard is faint. When the handle of the vibrating tuning fork is held against table, it sets up forced vibrations in the table top. As the table top has a larger surface area, therefore, large volume of air is set into vibrations, thereby producing a loud sound.

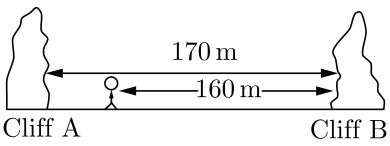
153. Why are stringed musical instruments provided with large sound boxes?

Ans : SQP 2002

A large sound box contains a large amount of trapped air. When the vibrations of the vibrating string are impressed upon the air, it sets up forced vibrations in the air column. As a large volume of enclosed air vibrates, a loud sound is produced.

THREE MARKS QUESTIONS

154. (a) Name the waves used in SONAR.



(b) In the above diagram Lata stands between two cliffs and claps her hands.
Determine the time taken by her to hear the first echo.
Speed of sound in air 320 ms^{-1}.

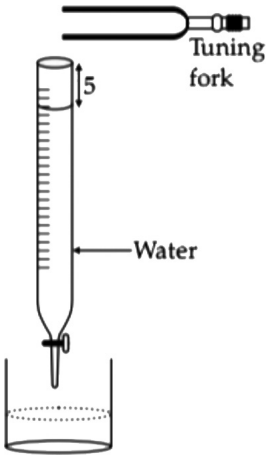
Ans : MAIN 2024

(a) Ultrasonic wave

(b) Lata cannot clearly distinguish the sound reflected from cliff A. Since the distance is less than the minimum distance required to hear a distinct echo.
So, she will hear the sound reflected from cliff B as 1st echo.
So, she will hear the 1st echo after time

$$t = \frac{2d}{v} = \frac{2 \times 160}{320} = 1 \text{ s}$$

155. In the given diagram, a vibrating tuning fork is kept near the mouth of a burette filled with water. The length of the air column is adjusted by opening the tap of the burette. At a length of 5 cm of the air column, a loud sound is heard.



(a) Name the phenomenon illustrated by the above experiment.

(b) Why is a loud sound heard at this particular length?

(c) If the present tuning fork is replaced with a tuning fork of higher frequency, should the length of the air column increase or decrease to produce a loud sound? Give a reason.

Ans : MAIN 2024

(a) Resonance

(b) Natural frequency of the air column matched with the frequency of the tuning fork.

(c) Length of air column should be decrease. Since frequency is inversely proportional to the air column.

156. Rohit playing a flute and Anita playing a piano emit sounds of same pitch and loudness.

Click Here to Buy book on Amazon

(i) Name one characteristic that is different for waves from the two different instruments.
(ii) If now the loudness of the sound from flute becomes four times that of the sound from piano, then write the value of the ratio $A_F : A_P$ (where, A_F = amplitude of sound wave from flute, A_P = amplitude of sound wave from piano)
(iii) Define pitch of a sound.

Ans : COMP 2000

(i) The quality of sound is that characteristic of sound which enables us to distinguish one sound from another having the same pitch and loudness.
(ii) Given,

$$(\text{Loudness})_{\text{flute}} = 4 \times (\text{Loudness})_{\text{piano}}$$

$$\text{Loudness} \propto (\text{Amplitude})^2$$

$$\frac{(\text{Loudness})_{\text{flute}}}{(\text{Loudness})_{\text{piano}}} = \frac{(\text{Amplitude})^2_{\text{flute}}}{(\text{Amplitude})^2_{\text{piano}}}$$

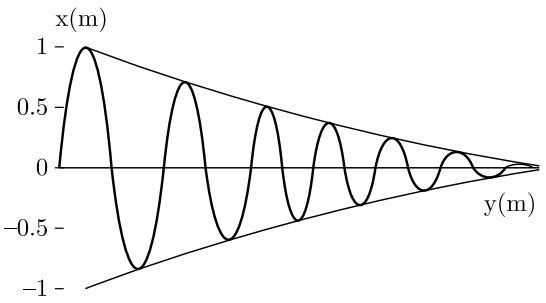
$$\frac{(\text{Amplitude})_{\text{flute}}}{(\text{Amplitude})_{\text{piano}}} = \frac{A_F}{A_P} = \sqrt{4}$$

$$\frac{A_F}{A_P} = 2$$

$$A_F : A_P = 2 : 1$$

(iii) Pitch of a sound is that subjective property which distinguishes a sharp sound from a dull sound. Pitch depends on an objective quantity frequency of the source (ν).

157. Study the below figure and answer the following:



(i) What type of vibration does the above figure represent?
(ii) State one reason for which the amplitude of the vibration decreases with time.
(iii) Write an example of natural vibrations.

Ans : SEM-II 2022

(i) The vibration which is represented in the above figure is damped vibration.
(ii) The amplitude of vibration decreases with time due to the presence of resistive force.
(iii) If a tuning fork is struck against a hard rubber pad, it vibrates with its natural frequency.

158. Name the factor that determines :
(i) Loudness of the sound heard
(ii) Quality of the note
(iii) Pitch of the note

Ans : MAIN 2017

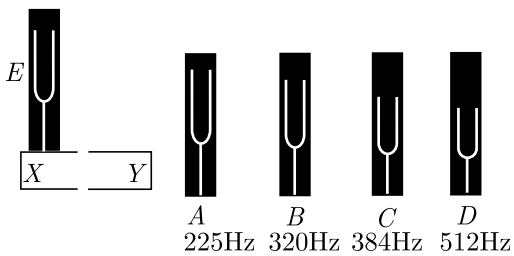
(i) Intensity/Amplitude.
(ii) Frequency of source and relative motion between the source of sound and the listener.
(iii) The number and the frequency of the overtones present in a given sound.

159. Sometimes when a vehicle is driven at a particular speed, a rattling sound is heard. Explain briefly, why this happens and give the name of the phenomenon taking place.

Ans : SQP 2008

It happens due to resonance. When a vehicle is driven, the piston of the engine makes in and out motion at a frequency depending upon its speed. The vibrations caused by the movement of piston are transmitted to all parts of the vehicle. It is just possible that some parts of the vehicle (or its frame), may have natural frequency of to and fro movement of piston at a certain speed of the vehicle. When this happens, then at this particular speed of the vehicle that part starts vibrating vigorously due to resonance.

160. The diagram below shows a vibrating tuning fork E mounted on a sound box X. When the vibrating tuning forks A, B, C and D are placed on the sound box Y one by one, it is observed that a louder sound is produced when the tuning fork B is placed on Y.



(i) What is the frequency of tuning fork E ?
(ii) Why does B produce a louder sound?

Ans : SEM-II 2022

(i) As the tuning fork B produces louder sound when placed on Y, then the frequency of

Downloaded from www.pdf.tube

135. What change, if any, would you expect in the characteristics of musical sound when we increase:
(i) its frequency and
(ii) its amplitude ?

Ans : SQP 2009

(i) Pitch of sound will increase.
(ii) Loudness of sound will increase.

136. What should be the minimum distance between a source of sound and the reflector to hear the echo distinctly?

Ans : COMP 2015

As the speed of sound is $340\ \text{ms}^{-1}$ and sensation of any sound persists in our ear for about 0.1 s. So, the distance travelled by sound in 0.1 s is $340\ \text{ms}^{-1} \times 0.1\ \text{s} = 34\ \text{m}$ which is twice the minimum distance between a source of sound and the reflector. So, the obstacle should be at least at a distance of $\frac{34}{2}\ \text{m} = 17\ \text{m}$.

137. What do you mean by percussion instruments? Give a few examples.

Ans : MAIN 2020

Percussion instruments are the instruments which are sounded by shaking them or by hitting them with the hand, a stick or a mallet. Few instruments are Kettle drum (timpani), Snare drum, Bongo drums, Bass drums, Vibraphone, Cymbals, Gongs, Marimbas, Castanets, Tambourines, Chimes, Sleigh bells, etc.

138. Name any two electromagnetic waves which have a frequency higher than that of violet light. State one use of each.

Ans : SQP 2023

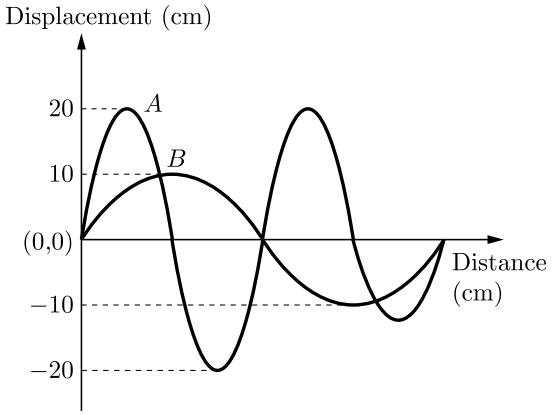
(i) Ultraviolet: For purifying water or to detect adulteration in ghee.
(ii) X-rays: It is used for detection of fractures in the bones.

139. State two ways by which the frequency of transverse vibrations of a stretched string can be decreased.

Ans : COMP 2010

Frequency of transverse vibrations of a stretched string can be decreased:
(i) by increasing the mass per unit length (m) of the string keeping length of string (l) and tension in the string (T) constant and
(ii) by decreasing the tension on the string (T) keeping length of the string (l) and mass per unit length of the string (m) constant.

140. Displacement-distance graph of two sound waves A and B, travelling in a medium, are as shown in the diagram given below.



Study the two sound waves and compare their :
(i) Amplitudes
(ii) Wavelengths

Ans : MAIN 2018

(i) $\frac{A_A}{A_B} = \frac{20}{10} = 2$
(ii) $\lambda_B > \lambda_A$

141. (i) State the safe limit of sound level in terms of decibel for human hearing.
(ii) Name the characteristic of sound in relation to its waveform.

Ans : SQP 2022

(i) Safe limit of sound level for human hearing is upto 120 dB.
(ii) Quality is that subjective characteristic of sound which enables us to distinguish between two sounds of the same loudness and same pitch but emitted by two different sources.

142. What is the principle on which SONAR is based ?

Ans : COMP 2013

Echo depth sounding.
Ultrasonic waves have the same speed as of audible sound but are not absorbed in the medium. So transmitter sends these waves receiver receives the waves back after striking the rigid obstacle so time taken is recorded. And we can calculate distance $d = \frac{vt}{2}$.

NODIA

Download NODIA App for All Sample Papers PDFs

should be at least 18 m (>17 m), so echo will be heard.

(b) Resonance: It occurs when the frequency of the vibrations of the air column becomes equal to or integral multiple of the frequency of the vibrating tuning fork.

166. A Burette filled with water. The tap is opened and the water level gradually falls. It is observed that the sound becomes the loudest for a particular length of air column.

(a) What is the name of the phenomenon taking place when this happens?

(b) Why does the sound become the loudest?

(c) What is the name of the phenomenon taking place when sound is produced for another length of air column and is not the loudest?

Ans : SQP 2019

(a) Resonance corresponding to the fundamental mode of vibration of the air column.

(b) Because the frequency of the particular length of air column in the tube becomes equal to the frequency of the vibrating tuning fork then amplitude become large so also loudness.

(c) Resonance corresponding to the first harmonic mode of vibration of air column.

167. A vibrating tuning fork is placed over the mouth of

(a) A stringed musical instrument, such as the Sitar, is provided with a number of wires of different thickness's. Explain the reason for this.

(b) What is meant by noise pollution? Write the name of one source of sound that causes noise pollution.

Ans : COMP 2013

(a) The frequency of vibration depends on the mass per unit length of the wire which depends on the thickness of the wire.

(b) A sound which produces an unpleasant effect on the ear.

Noise levels in many urban-industrial complexes are detrimental to human health. They have adverse effects on the sense organs, glandular, cardiovascular and nervous system. Its sources are gadgets like vacuum cleaner, mixer, loudspeakers, coolers, generators and crackers, etc.

168. What is Sonar? State the principle on which it is based.

Ans : MAIN 2019

SONAR means sound navigation and ranging. Sonar is an instrument that makes use of ultrasonic waves for sound ranging. It is equipped to measure even short time intervals quite accurately.

Sonar works on the principle of echoes. A strong and short (ultrasonic) sound signal is sent towards the bottom of the ocean. The echo of this signal is then detected by it. By noting the time after which the reflected sound (echo) reaches back, we can calculate the depth of the ocean by using the formula.

Depth of ocean $= v \times t/2$, where v is the velocity of the ultrasonic wave.

169. Define intensity and loudness of sound. How is loudness connected with the intensity of sound?

Ans : SQP 2015

Intensity of sound at any point in space is defined as amount of vibrational energy passing per unit time per unit area around that point in a direction normal to the area. Its SI unit is W/m^2.

Loudness is the sensation produced in the ear which enables to distinguish between a loud and a faint sound.

Relation between loudness (L) and intensity (I)

$$L = \log_{10}\left(\frac{I}{I_0}\right)$$

Where I_0 is the threshold of hearing (lowest intensity of sound that can be perceived by the human ear $\sim 10^{-12}\,W/m^2$).

170. Name the factors on which the frequency of vibrating string depends. What happens if the string is to vibrate in more than one segment ?

Ans : COMP 2020

If the string vibrates as a whole in one segment, the frequency of vibrations is the lowest and is called the fundamental frequency.

The frequency of vibrating string depends on the following :

(i) The law of length, $n \propto \frac{1}{l}$ ...(1)

(ii) The law of tension, $n \propto \sqrt{T}$ ...(2)

(iii) The law of mass, $n \propto \frac{1}{\sqrt{m}}$ ...(3)

On combining eqs. (1), (2) and (3), we have

$$n \propto \frac{1}{l}\sqrt{\left(\frac{T}{m}\right)}$$

$$n = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

When the number of segments is increased, then

Click Here to Buy book on Amazon

123. How do you account for the fact that two strings can be used to give notes of the same pitch and loudness but of different quality?

Ans : COMP 2023

The 'quality' of a given note is determined by the overall effect of the harmonics present in it. The harmonics are multiples of the fundamental or basic frequency of the 'note'. Depending on the conditions under which vibrations are taking place, sometimes we get one set of harmonics and sometimes another set. The quality of the two notes will, therefore, differ even though their fundamental frequencies may be the same.

124. Differentiate between sound and light waves.

Ans : MAIN 2003

The difference between sound and light waves are as follows:

	Sound wave	**Light wave**
(i)	Sound waves require a medium for propagation.	Light waves do not require a medium for propagation.
(ii)	Sound waves travel with a speed of 332 m/s.	Light waves travel with a speed of 3×10^8 m/s.
(iii)	Sound waves are longitudinal waves consisting of compressions and rarefactions.	All electromagnetic waves are transverse waves consisting of varying electric and magnetic field.
(iv)	All of different frequencies, giving notes of different pitches.	All of different frequencies, resulting in different colours.
(v)	Sound waves do not travel far off as their energy is dissipated easily.	Light waves can travel through a much greater distance as they contain greater energy.

125. Bats have no eyes still they can ascertain distances, directions, nature and size of the objects. Explain why?

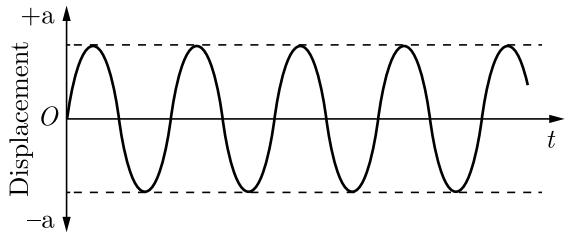
Ans : COMP 2009

Bats have special types of wings. When they fly they produce ultrasonic waves. These waves are received by the ears of bat after they have been reflected by the object. The ears of the bats are so sensitive and trained that they not only get information of distance of the obstacle but also that of the nature of the reflecting surface.

126. (a) Draw a graph between displacement and the time for a body executing free vibrations.
(b) Where can a body execute free vibrations?

Ans : SQP 2002

(a) Displacement-time graph for a body executing free vibrations.



(b) A body can execute free vibrations in vacuum.

127. (a) What is meant by an echo? Mention one important condition that is necessary for an echo to be heard distinctly.
(b) Mention one important use of echo.

Ans : COMP 2008

(a) Echo is the sound heard after it gets reflected from a rigid surface.
There should be a minimum distance of 16.6 m (ν of sound = 332 m/s) between the listener and the reflecting surface.
(b) Used in Sonar/Radar/by fisherman, etc.

128. Define the terms:
(i) Amplitude
(ii) Frequency (as applied to sound waves)

Ans : MAIN 2021

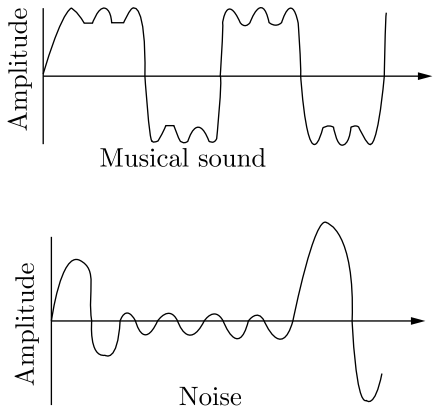
(i) Amplitude is the maximum displacement of an oscillating particle of the medium of a periodic wave on either side of the mean position. It is represented by A, its SI unit is metre.
(ii) Frequency is the number of complete wavelengths traversed by a wave per second. It is represented by ν. Its SI unit is hertz (Hz).

129. What are damped vibrations? Draw the displacement-time graph for damped and undamped vibrations.

Ans : SQP 2016

The periodic vibrations of decreasing amplitude

NODIA



176. (a) State two differences between light waves and sound waves.

(b) Two waves of the same pitch have their amplitudes in the ratio 2 : 3.

(i) What will be the ratio of their loudness ?

(ii) What will be the ratio of their frequencies?

Ans : MAIN 2001

(a) Differences between light waves and sound waves are as follows :

	Light waves	**Sound waves**
(i)	Light waves are electromagnetic waves.	Sound waves are mechanical waves.
(ii)	Light waves are transverse in nature.	Sound waves are longitudinal in nature.
(iii)	The speed of light waves is $3 \times 10^8\ \text{ms}^{-1}$.	The speed of sound waves is $332\ \text{m s}^{-1}$.

(b) (i) Ratio of loudness $= 4:9$ as loudness depends upon intensity which is directly proportional to the square of the amplitude.

(ii) Ratio of frequencies $= 1:1$ as pitch depends upon the frequency.

177. (a) What do you understand by the terms: (i) wavelength, (ii) frequency and (iii) amplitude of a wave ?

(b) Which of the above determine the loudness of a sound wave? What is the relationship between loudness and your answer in (ii) (a) above ?

Ans : SQP 2006

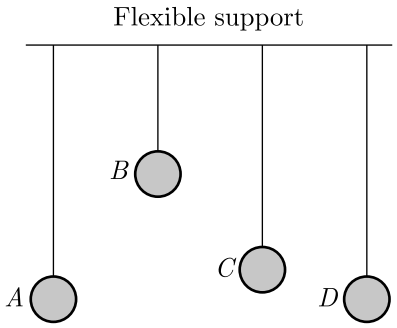
(a) (i) Wavelength of a wave is defined as the length of one complete wave or the distance travelled by wave in its time period. It is represented by λ. Its SI unit is metre (m).

(ii) Frequency is the number of complete wavelengths travelled by a wave per second. It is represented by ν. Its SI unit is hertz (Hz).

(iii) Amplitude is the maximum displacement of an oscillating particle of the medium of a periodic wave on either side of the mean position. It is represented by a or A, its SI unit is metre.

(b) Loudness of a sound is determined by amplitude of a sound wave. Sound of greater amplitude will be always louder as we know $L \propto A^2$ where L – loudness of sound, A – amplitude.

178. In the given figure pendulum (A) is set into vibrations, which of the other three will vibrate with maximum amplitude and why?

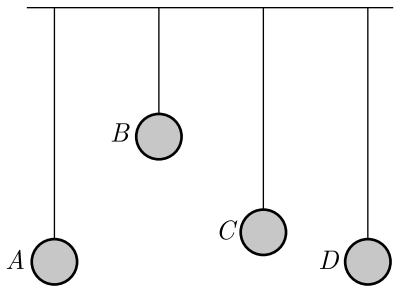


Ans : COMP 2023

According to the shown figure the pendulums (A) and (D) are of the same length, therefore, their frequencies of the vibrations are the same. Now if pendulum (A) is displaced from its mean position, let it performs natural vibrations which causes the flexible support to vibrate with the frequency of (A). Through the support, these vibrations are transferred to the other pendulums due to which other pendulums also begin to vibrate with the natural frequency of (A).

Pendulums (B) and (C) vibrate with smaller amplitude than that of (A) but with the same frequency as that of (A). Pendulums (B) and (C) are in the state of forced vibrations. Pendulum (D) also starts vibrating and ultimately acquires the same amplitude as that of (A). Pendulum (D) being of the same length attains the state of resonance.

Downloaded from www.pdf.tube



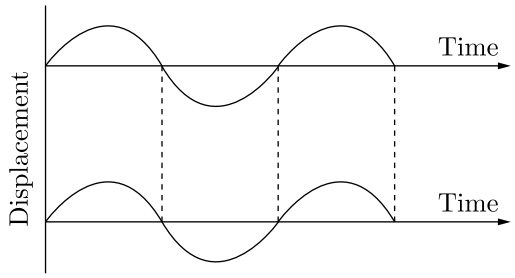
179. What do you understand by the term "quality" of a musical note ? Illustrate your answer with a diagram.

Ans : COMP 2005

Quality or Timbre is the property by which two notes of the same pitch and possibly of the same intensity given by two different instruments can be distinguished from each other.

The quality depends upon the presence of secondary or subsidiary frequencies. The number of these frequencies present in a wave along with their intensities are different in different musical instruments and for this reason the quality of sound is different for different instruments.

The diagram given below shows the sounds of same fundamentals produced by two different Instruments. However, the quality of sound by the two sources is different.

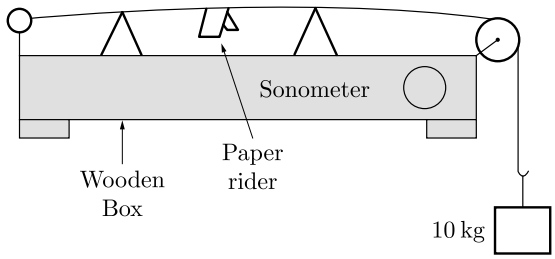


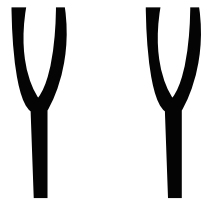
180. (i) Name the waves used for echo depth sounding.
(ii) Give one reason for their use for the above purpose.
(iii) Why are the waves mentioned by you not audible to us?

Ans : SQP 2016

(i) Waves used for echo depth sounding are ultrasonic waves.
(ii) Ultrasonic waves can travel through long distances without deviation.
(iii) Frequency of ultrasonic waves is above 20000 Hz while the frequency of audible range is 20 Hz to 20000 Hz.

181.





The diagram above shows a wire stretched over a sonometer. Stems of two vibrating tuning forks A and B are touched to the wooden box of the sonometer. It is observed that the paper rider (a small piece of paper folded at the centre) present on the wire flies off when the stem of vibrating tuning fork B is touched to the wooden box but the paper just vibrates when the stem of vibrating tuning fork A is touched to the wooden box.

(i) Name the phenomenon when the paper rider just vibrates.
(ii) Name the phenomenon when the paper rider flies off.
(iii) Why does the paper rider fly off when the stem of tuning fork B is touched to the box ?

Ans : MAIN 2018

(i) Forced vibrations.
(ii) Resonance.
(iii) The wire of the sonometer begins to vibrate with its natural frequency. This is called resonance. At resonance the amplitude of vibration becomes very large.

182. What do you understand by the terms ?
(i) Wavelength,
(ii) Frequency and
(iii) Amplitude of a wave.

Ans : MAIN 2022

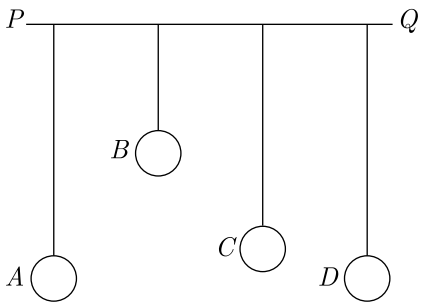
(i) **Wavelength :** The linear distance covered by one complete wave is called wavelength.
(ii) **Frequency :** The number of vibrations made by a vibrating particle of a medium about

NODIA

its mean position in one second is called frequency.

(iii) **Amplitude :** The maximum displacement of a vibrating particle about its mean position is called amplitude.

183. In the diagram below A, B, C, D, are four pendulums suspended from the same elastic string PQ. The length of A and C are equal to each other while the length of pendulum B is smaller that of D. Pendulum A is set into a mode of vibrations.



(i) Name the type of vibrations taking place in pendulums B and D ?

(ii) What is the state of pendulum C ?

(iii) State the reason for the type of vibrations in pendulums B and C.

Ans : COMP 2020

(i) Pendulums B and D execute forced vibrations.

(ii) Pendulum C will be in the state of resonance.

(iii) Natural frequency of pendulum B does not match with natural frequency of pendulum A. Natural frequency of pendulum C matches with the natural frequency of pendulum A.

FOUR MARKS QUESTIONS

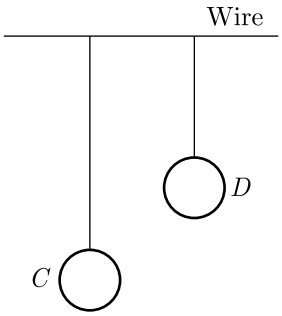
184. Two pendulums C and D are suspended from a wire as shown in the given figure. Pendulum C is made to oscillate by displacing it from its mean position. It is seen that D also starts oscillating.

(i) Name the type of oscillation, C will execute.

(ii) Name the type of oscillation, D will execute.

(iii) If the length of D is made equal to C, then what difference will you notice in the oscillations of D ?

(iv) What is the name of the phenomenon when the length of D is made equal to C ?



Ans : COMP 2019

(i) Free or natural oscillation.

(ii) Forced oscillation.

(iii) The amplitude of the oscillation of D will be equal to the amplitude of the oscillation of C.

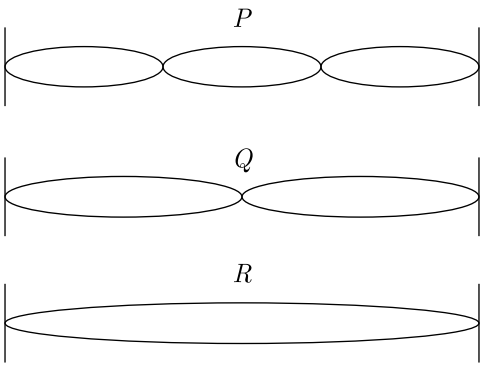
(iv) Resonance.

185. The diagram shows three different modes of vibrations P, Q and R of the same string.

(i) Which vibration will produce a louder sound and why?

(ii) The sound of which string will have maximum shrillness?

(iii) State the ratio of wavelengths of P and R.



Ans : MAIN 2000

(i) The loudness or softness of a sound is determined by the amplitude (or intensity) of the wave. In this case the amplitude of R is greater than the amplitude of other vibration modes.

Hence, the vibration R will produce more sound than the other two. Louder sound corresponds to the wave of larger amplitude.

(ii) Shrillness or Pitch of a note depends on the wavelength or frequency of wave and here the vibration P has more frequency than others. If f is the principle frequency, then

Frequency, $P = 3f$,

Click Here to Buy book on Amazon

$$t = \frac{2d}{\nu}$$
$$= \frac{2 \times 68\ \text{m}}{340\ \text{m s}^{-1}} = 0.4\ \text{s}$$

207. A radar is able to detect the reflected waves from an enemy aeroplane, after a time interval of 0.02 millisecond. If the velocity of the waves is $3 \times 10^8\ \text{ms}^{-1}$, calculate the distance of the plane from the radar.

Ans : SQP 2005

Time, $t = 0.02$ millisecond
$= 0.02 \times 10^{-3}\ \text{s}$
$c = 3 \times 10^8\ \text{ms}^{-1}$

Let 'd' be the distance of the plane from the radar. Then

$2d =$ Velocity $\times$ time
$= 3 \times 10^8 \times 0.02 \times 10^{-3}$
$2d = 6000\ \text{m}$
$d = 3000\ \text{m} = 3\ \text{km}$

208. The wavelength of waves produced on the surface of water is 20 cm. If the wave velocity is 24 ms^{-1}, calculate :

(i) the number of waves produced in one second and

(ii) the time required to produce one wave.

Ans : COMP 2004

Wavelength, $\lambda = 20\ \text{cm} = 0.20\ \text{m}$
$v = 24\ \text{ms}^{-1}$

(i) As we know that,

$$v = f\lambda$$
$$f = \frac{v}{\lambda} = \frac{24}{0.20} = 120\ \text{Hz}$$

(ii) Time required to produce one wave i.e. Time period is given by

$$T = \frac{1}{f} = \frac{1}{120\ \text{s}} = 0.0083\ \text{s}$$

209. A pendulum has a frequency of 5 vibrations per second. An observer starts the pendulum and fires a gun simultaneously. He hears the echo from the cliff after 8 vibrations of the pendulum. If the velocity of sound in air is 340 ms^{-1}, what is the distance between the cliff and the observer ?

Ans : MAIN 2003

Given, Frequency, $f = 5\ \text{Hz}$

As we know that,

$$T = \frac{1}{f} = \frac{1}{5} = 0.2\ \text{s}$$

Therefore, time for 8 vibrations

$$t = 8 \times 0.2 = 1.6\ \text{s}$$
$$v = 340\ \text{ms}^{-1}$$

During the given time, the sound wave travels the distance between the cliff and the gun twice. Therefore, using the expression

$$d = \frac{v \times t}{2}$$
$$= \frac{340 \times 1.6}{2} = 272\ \text{m}$$

210. A radar sends a signal to an aircraft at a distance of 30 km away and receives it back after 2×10^{-4} second. What is the speed of the signal ?

Ans : SQP 2014

Given, $t = 2 \times 10^{-4}\ \text{s}$, $d = 30\ \text{km} = 30 \times 10^{-3}\ \text{m}$,

Let 'd' be the distance of aircraft from the radar, then the total distance travelled by the wave in coming and going back $= 2d$

$$\text{Velocity of wave, } V = \frac{\text{total distance travelled}}{\text{time taken}}$$
$$V = \frac{2 \times (30 \times 10^3)}{2 \times 10^{-4}}$$
$$= 3 \times 10^8\ \text{ms}^{-1}$$

211. Calculate the minimum distance at which a person should stand in front of a reflecting surface so that he can hear a distinct echo. (Take speed of sound in air $= 350\ \text{ms}^{-1}$.)

Ans : COMP 2006

Minimum distance to hear a distinct echo

$$= \frac{350\ \text{m s}^{-1} \times 0.1\ \text{s}}{2}$$
$$= 17.5\ \text{m}$$

(Persistence of hearing = 0.1 s)

212. What is the order of wavelength of visible light and audible sound?

Ans : MAIN 2010

Wavelength, $\lambda = \frac{\nu}{v}$

For visible light ($v = 5 \times 10^{14}\ \text{Hz}$)

$$\lambda = \frac{3 \times 10^8\ \text{m s}^{-1}}{5 \times 10^{14}\ \text{Hz}}$$
$$= 6 \times 10^{-7}\ \text{m}$$

For audible sound (20 Hz – 20000 Hz)

$$\lambda = \frac{332\ \text{m s}^{-1}}{20\ \text{Hz}} = 16.6\ \text{m}$$

NODIA

$$= \frac{(336 \times 1.5)}{2}$$

$$= 168 \times 1.5 = 252 \text{ m away.}$$

190. A man standing in front of a vertical cliff fires a gun. He hears the echo after 3.5 seconds. On moving closer to the cliff by 84 m, he hears the echo after 3 seconds. Calculate the distance of the cliff from the initial position of the man.

Ans : MAIN 2020

In the first case, we have

$$v = \frac{2d}{t} = \frac{2d}{3.5} \quad ...(1)$$

In the second case, we have

$$v = \frac{2d}{t} = \frac{2(d-84)}{3} \quad ...(2)$$

From (1) and (2), we have

$$\frac{2d}{3.5} = \frac{2(d-84)}{3}$$

$$6d = 7d - 588$$

$$d = 588 \text{ m}$$

191. An observer stands at a certain distance away from a cliff and produces a loud sound. He hears the echo of the sound after 1.8 s. Calculate the distance between the cliff and the observer if the velocity of sound in air is 340 ms^{-1}.

Ans : SQP 2013

Given, $t = 1.8 \text{ s}$

$$v = 340 \text{ ms}^{-1}$$

As we know that,

$$d = \frac{vt}{2}$$

$$= \frac{340 \times 1.8}{2} = 306 \text{ m}$$

192. A sound wave travelling in water has a wavelength 0.4 m. Is this wave audible in air ? (The speed of sound in water $= 1400 \text{ ms}^{-1}$)

Ans : COMP 2020

Given, $\lambda = 0.4 \text{ m}$

As we know that,

$$v = f\lambda$$

We have, $f = \frac{v}{\lambda}$

$$= \frac{1400}{0.4} = 3500 \text{ Hz}$$

Since this lies in the audible range (20 to 20000 Hz), it will be audible.

193. A pendulum has a frequency of 4 vibrations per second. An observer starts the pendulum and fires a gun simultaneously. He hears the echo from the cliff after 6 vibrations of the pendulum. If the velocity of sound in air is 340 in s^{-1}, find the distance between the cliff and the observer.

Ans : MAIN 2019

Given, $f = 4 \text{ vbs}$,

$$T = \frac{1}{f} = \frac{1}{4} = 0.25 \text{ s},$$

For a frequency of 6 vbs time

$$t = \frac{0.25}{4} \times 6 = 0.375 \text{ s}$$

$$v = 340 \text{ ms}^{-1}$$

As we know that,

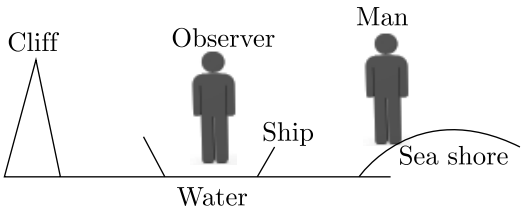
$$S = \frac{v \times t}{2}$$

$$= \frac{340 \times 0.375}{2} = 63.75 \text{ m}$$

194. A person is standing at the sea shore. An observer on the ship, which is anchored in between a vertical cliff and the person on the shore, fires a gun. The person on the shore hears two sounds, 2 seconds and 3 seconds after seeing the smoke of the fired gun. If the speed of sound in the air is 320 ms^{-1}, then calculate :

(i) the distance between the observer on the ship and the person on the shore.

(ii) the distance between the cliff and the observer on the ship.



Ans : SQP 2018

Let distance between the observer on the ship and person on the shore be x. For the first sound which the person hears after 2 second, we have

$$v = \frac{x}{t}$$

$$x = vt = 320 \times 2 = 640 \text{ m}$$

Let distance between the ship and the cliff be x, then, in the second case

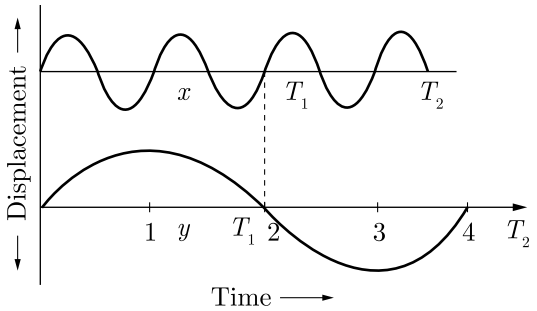
$$v = \frac{2x + 640}{t}$$

$$2x + 640 = vt = 320 \times 3 = 960$$

or $2x = 960 - 640 = 320 \text{ m}$

$$x = \frac{320}{2} = 160 \text{ m}$$

NODIA



Ans : MAIN 2006

(i) Velocity of two waves will be same as the medium of their propagation is the same

$$\frac{v_x}{v_y} = 1$$

$$v_x : v_y = 1:1$$

(ii) From the figure, it is clear that during the same time T_1 seconds two waves of x wave and half wave of y wave is sent into the medium.

$$2\lambda_x = \frac{\lambda_y}{2}$$

$$\frac{\lambda_x}{\lambda_y} = \frac{1}{4}$$

$$\lambda_x : \lambda_y :: 1:4$$

(iii) $$\frac{f_x}{f_y} = \frac{v_x}{\lambda_x} \times \frac{\lambda_y}{v_y} = \frac{\lambda_y}{\lambda_x} = \frac{4}{1}$$

(iv) Wave x will be shriller because the frequency of x is greater.

(v) Wave y will be louder because the amplitude of y is greater.

218. A person standing between two vertical cliffs and 640 in away from the nearest cliff shouted. He heard the first echo after 4 seconds and the second echo 3 seconds later. Calculate (i) the velocity of sound in air and (ii) the distance between the cliffs.

Ans : SQP 2022

(i) For the first echo, the sound takes a time of 2 seconds to reach the nearest cliff which is 640 m, therefore, using the formula

$$v = \frac{S}{t}$$

$$= \frac{640}{2} = 320\ \text{ms}^{-1}$$

(ii) Let x be the distance of the second cliff from the person. Now, distance travelled by the second echo to the second cliff is

$$x = v \times t$$

$$= 320 \times 3.5 \ = 1120\ \text{m}$$

Therefore, the distance between the two cliffs is

$$D = 640 + x$$

$$= 640 + 1120 = 1760\ \text{m}$$

219. A sound made on the surface of a lake takes 3 s to reach a boatman.
How much time will it take to reach a diver inside the water at the same depth ?
Velocity of sound in air $= 330\ \text{m s}^{-1}$
Velocity of sound in water $= 1450\ \text{m s}^{-1}$

Ans : COMP 2018

Distance travelled by sound to reach a boatman on the surface of lake,

$$d = \nu \times t$$

$$= 330\ \text{m s}^{-1} \times 3\ \text{s} \ = 990\ \text{m}$$

Time taken by sound to reach a diver at a depth of 990 m inside the water,

$$t' = \frac{d}{\nu'} \ = \frac{990\ \text{m}}{1450\ \text{m s}^{-1}} \ = 0.68\ \text{s}$$

220. What type of waves are produced when a bell rings in air ? A string vibrates with a frequency of 500 Hz. If the distance between two consecutive troughs of a transverse wave produced in the string is 20 cm, find the velocity and the period of the wave.

Ans : SQP 2010

Longitudinal waves are produced in air.
The distance between two consecutive troughs of a transverse wave is called wavelength

i.e. $$\lambda = 20\ \text{cm} = 0.2\ \text{m}$$

$$\nu = \nu\lambda$$

$$\nu = 500\ \text{Hz} \times 0.2\ \text{m}$$

$$= 100\ \text{m s}^{-1}$$

$$T = \frac{1}{\nu} \ = \frac{1}{500\ \text{Hz}} = 0.002\ \text{s}$$

221. A longitudinal wave of wavelength 1 cm travels in air with a speed of 330 ms^{-1}. Calculate the frequency of the wave. Can this wave be heard by a normal human being?

Ans : COMP 2002

Given, $\lambda = 1\ \text{cm} = 0.01\ \text{m}$

$v = 330\ \text{ms}^{-1}$

Using, $v = f\lambda$, we have

Downloaded from www.pdf.tube

(b) The distance of the other cliff from the person

$$d_2 = \frac{\nu \times t_2}{2}$$

$$= \frac{320\ \text{m s}^{-1} \times (3+2)\ \text{s}}{2}$$

$$= 160\ \text{m s}^{-1} \times 5\ \text{s} = 800\ \text{m}$$

202. A sound made on the surface of a lake takes 3 s to reach a boatman.
How much time will it take to reach a diver inside the water at the same depth ?
Velocity of sound in air $= 330\ \text{ms}^{-1}$
Velocity of sound in water $= 1450\ \text{ms}^{-1}$

Ans : SQP 2013

depth is same or d is same.

So, $d = vt$ (in air)

$$= 330 \times 3 = 990\ \text{m}$$

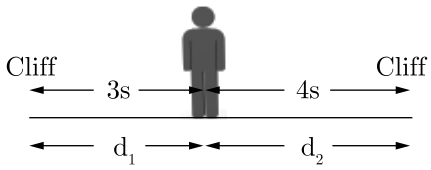
So, time required in water

$$t = \frac{d}{v} = \frac{990}{1450} = 0.68\ \text{s}$$

203. (a) A man standing between two cliffs produces a sound and hears two successive echoes at intervals of 3 s and 4 s respectively. Calculate the distance between the two cliffs. The speed of sound in the air is 330 m s^{-1}.
(b) Why will an echo not be heard when the distance between the source of sound and the reflecting surface is 10 m?

Ans : COMP 2012

(a)



Distance of the man from nearer cliff,

$$d_1 = \frac{\nu \times t_1}{2}$$

$$= \frac{330\ \text{m s}^{-1} \times 3\ \text{s}}{2} = 495\ \text{m}$$

Distance of the man from another cliff,

$$d_2 = \frac{\nu \times t_2}{2}$$

$$= \frac{330\ \text{m s}^{-1} \times 4\ \text{s}}{2} = 660\ \text{m}$$

(b) Total distance between two cliffs

$$d = d_1 + d_2$$

$$= 495 + 660 = 1155\ \text{m}$$

204. A man standing 25 m away from a wall produces a sound and receives the reflected sound.
(i) Calculate the time after which he receives the reflected sound if the speed of sound in air is 350 ms^{-1}.
(ii) Will the man be able to hear a distinct echo? Give a reason for your answer.

Ans : MAIN 2011

(i) Time $= \frac{2d}{v} = \frac{2 \times 25}{350} = 0.14$ sec

(ii) Yes, because distance is more than 17 m and time period is 0.14 sec.

205. A person standing between two vertical cliffs and 480 m from the nearest cliff shouts. He hears the first echo after 3 s and the second echo 2 s later. Calculate:
(i) The speed of sound.
(ii) The distance of the other cliff from the person.

Ans : SQP 2015

(i) The first echo is heard from the nearest cliff. Let d_1 be the distance of the nearest cliff. Then distance travelled by sound in going and coming back from the nearest cliff is

$$S_1 = 2d_1 = 480 \times 2 = 960\ \text{m}$$

Time interval $t_1 = 3\ \text{s}$

Therefore, Speed of sound is

$$v = \frac{\text{Total distance travelled}}{\text{Time taken}}$$

$$= \frac{960}{3} = 320\ \text{ms}^{-1}$$

(ii) The second echo is heard from the farther cliff. If d_2 is the distance from the person, then distance travelled by sound $S_2 = 2d_2$ and time taken $t_2 = 3 + 2 = 5\ \text{s}$

Now, $v = \frac{S_2}{t_2}$

$$320 = \frac{S_2}{5}\ \text{ms}^{-1}$$

Therefore, $S_2 = 320 \times 5 = 1600\ \text{m}$

206. A man stands at a distance of 68 m from a cliff and fires a gun. After what time interval will he hear the echo, if the speed of sound in air is 340 m s^{-1} ?

Ans : MAIN 2022

Given, $d = 68\ \text{m}$,

$\nu = 340\ \text{m s}^{-1}$

As we know that,

NODIA

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!

Frequency, $Q = 2f$

and Frequency, $R = f$

Hence, P has more shrillness than others.

(iii) If the frequency of vibration of $R = f$, frequency of vibration of $Q = 2f$ and that of $P = 3f$.

$$\text{Ratio} = \frac{f_P}{f_R} = \frac{3}{1}$$

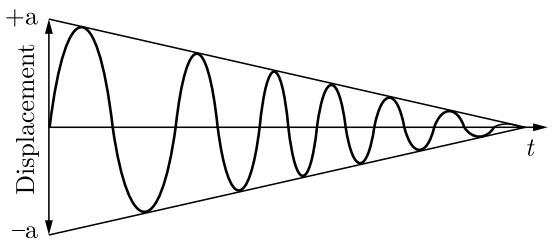
As, $f \propto \frac{1}{\lambda}$. Hence, $\frac{\lambda_P}{\lambda_R} = \frac{1}{3}$

186. (i) Name the phenomenon involved in tuning a radio set to a particular station.
(ii) Define the phenomenon named by you in part (i) above.
(iii) What do you understand by loudness of sound ?
(iv) In which units is the loudness of sound measured?

Ans : SQP 2016

(i) Resonance.
(ii) Resonance or acoustic resonance is a special case of forced vibrations. It occurs when the frequency of the applied periodic external force becomes equal to the natural frequency of the vibrating body.
(iii) Loudness is the degree of sensation of sound produced. It depends upon the intensity of sound waves near the ear and response (sensitivity) of the ear for the waves of that frequency.
(iv) The unit of loudness is phone.

187. The diagram below shows the displacement-time graph for a vibrating body.
(a) Name the type of vibrations produced by the vibrating body.
(b) Give one example of a body producing such vibrations.
(c) Why is the amplitude of the wave gradually decreasing ?
(d) What will happen to the vibrations of the body after sometime ?



Ans : SQP 2012

(a) Damped vibrations.
(b) A simple pendulum oscillating in air.
(c) The amplitude of vibrations gradually decreases due to friction.
(d) After sometime the vibrations of the body die out or the body comes to rest.

188. The stem of a tuning fork is pressed against a table top. Answer the following questions :
(i) Would the above action produce any audible sound ?
(ii) Does the above action cause the table to set into vibrations ?
(iii) If the answer above is yes, what type of vibrations are they ?
(iv) Under what conditions does the above action lead to resonance ?

Ans : COMP 2013

(i) Yes, there is an audible sound produced.
(ii) Yes, the table top is set into 'forced vibrations' by this.
(iii) The vibrations are forced vibrations.
(iv) Pressing the stem of a vibrating tuning fork against a table top, would lead to resonance if the frequency of the tuning fork equals the natural frequency of oscillations of the table top.

NUMERICAL QUESTION

189. A person standing in front of a cliff fires a gun and hears its echo after 3 s. If the speed of sound in air is 336 ms^{-1}.
(a) Calculate the distance of the person from the cliff.
(b) After moving a certain distance from the cliff, he fires the gun again and this time the echo is heard 1.5 s later than the first. Calculate the distance that the person moved.

Ans : SQP 2025

(a) $$d = \frac{(s \times t)}{2}$$
$$= \frac{(336 \times 3)}{2}$$
$$= 168 \times 3 = 504 \text{ m}$$

(b) $$d = \frac{(s \times t)}{2}$$

Click Here to Buy book on Amazon

$$\lambda = \frac{332\ \text{m s}^{-1}}{20000\ \text{Hz}}$$

$$= 16.6 \times 10^{-3}\ \text{m}$$

Wavelength of visible light is of the order of 6×10^{-7} m and audible sound in air varies from 16.6×10^{-3} m to 16.6 m.

213. A man fires a gun and hears its echo after 5 s. The man then moves 310 m towards the hill and fires his gun again. This time he hears the echo after 3 s. Calculate the speed of the sound.

Ans : SQP 2004

Given, $t_1 = 5\ \text{s}$

Let d be the distance of the hill from the man and v be the velocity of sound.

Then, $$t = \frac{2d}{v}$$

$$5 = \frac{2d}{v}$$

$$d = \frac{5v}{2} \quad \ldots(1)$$

When the man moves through a distance 310 m towards the wall, then $d' = d - 310$ and $t' = 3\ \text{s}$

$$t' = \frac{2d}{v}$$

$$3 = \frac{2(d-310)}{v}$$

$$d - 310 = \frac{3v}{2} \quad \ldots(2)$$

Subtracting (2) from (1), we have

$$d - d + 310 = \frac{5v}{2} - \frac{3v}{2}$$

$$= \frac{2v}{2} = v$$

$$310 = v$$

$$\text{Velocity of sound} = 310\ \text{ms}^{-1}$$

214. An observer sitting in between two vertical walls claps 10 times per second. He adjusts his distance 17 m from one wall in such a way that the sound of his clapping coincides with the echo. Calculate the velocity of sound.

Ans : SQP 2012

The observer claps 10 times per second, i.e. he claps at an interval of 0.1 s. Since the sound of echo coincides with the clap, therefore the echo is heard after 0.1 s. It means in 0.1 s, the sound travels $2 \times 17\ \text{m} = 34\ \text{m}$.

$$v = \frac{\text{distance}}{\text{time}}$$

$$= \frac{34\ \text{m}}{0.1\ \text{s}} = 340\ \text{m s}^{-1}$$

215. An ultrasonic wave is sent from a ship towards the bottom of the sea. It is found that the time interval between the sending and the receiving of the wave is 1.5 second. Calculate the depth of the sea if the velocity of sound in sea water is 1400 ms^{-1}.

Ans : COMP 2001

Time interval, $\Delta t = 1.5$ second

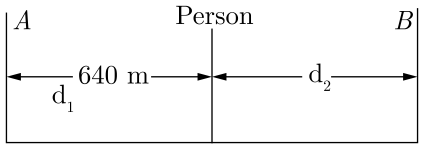
Velocity of sound in sea water,

$$v = 1400\text{ms}^{-1}$$

$$\text{Depth of the sea} = \frac{1400\ \text{m/s} \times 1.5\ \text{s}}{2}$$

$$= 1050\ \text{m}$$

216. A person standing between two vertical cliffs and 640 m away from the nearest cliff shouted. He heard the first echo after 4 seconds and the second echo 3 seconds later. Calculate (a) the velocity of sound in air and (b) the distance between the cliffs.



Ans : MAIN 2020

Given, $d_1 = 640\ \text{m};\ t_1 = 4\ \text{s};\ t_2 = 4 + 3 = 7\ \text{s}$

(a) First echo is heard from the nearest cliff A

$$v = \frac{\text{total distanace travelled}}{\text{total time taken}}$$

$$= \frac{2 \times 640\ \text{m}}{4\ \text{s}} = 320\ \text{m s}^{-1}$$

(b) Second echo is heard from the farthest cliff B

$$v = \frac{2d_2}{t_2}$$

$$320\ \text{m s}^{-1} = \frac{2d_2}{7\ \text{s}}$$

$$d_2 = 1120\ \text{m}$$

Hence the distance between the two cliffs

$$= d_1 + d_2$$

$$= 640\ \text{m} + 1120\ \text{m}$$

$$= 1760\ \text{m}$$

217. In the figure below, (x) and (y) are two waves which are represented graphically with displacement-time curves.

Calculate the ratio of their (i) Velocity, (ii) Wavelength, (iii) Frequency. Also, give reason which produces (iv) Shrill sound and (v) Louder sound.

NODIA

195. The human ear can detect continuous sounds in the frequency range from 20 Hz to 20000 Hz. Assuming that the speed of sound in air is 330 ms^{-1} for all frequencies, calculate the wavelengths corresponding to the given extreme frequencies of the audible range.

Ans : COMP 2017

The corresponding wavelengths are

$$\lambda_{lowest} = \frac{V}{v} = \frac{330}{20000}$$

$$= 0.0165\,m \text{ and}$$

$$\lambda_{highest} = \frac{V}{v} = \frac{330}{20}$$

$$= 16.5\,m$$

196. An enemy plane is at a distance of 300 km from a radar. In how much time the radar will be able to detect the plane ? Take velocity of radio waves as $3 \times 10^8\ ms^{-1}$.

Ans : MAIN 2017

Given, $S = 300\,km = 300000\,m$

$c = 3 \times 10^8\ ms^{-1},\ t = ?$

Using, $t = \frac{2S}{v}$

$$= \frac{2 \times 300000}{3 \times 10^8}$$

$$= 2 \times 10^{-3}\,s$$

197. A wire of length 80 cm has a frequency of 256 Hz. Calculate the length of a similar wire under similar tension, which will have frequency 1024 Hz.

Ans : SQP 2017

Given, $L_1 = 80\,cm,\ f_1 = 256\,Hz,\ L_2 = ?,$

$f_2 = 1024\,Hz$

for a vibrating string

$$L_f = \text{constant}$$

Therefore, we have

$$L_2 = \frac{L_1 f_1}{f_2}$$

$$= \frac{80 \times 256}{1024} = 20\,m$$

198. A certain sound has a frequency of 256 hertz and a wavelength of 1.3 m.

(i) Calculate the speed with which this sound travels.

(ii) What difference would be felt by a listener between the above sound and another sound traveling at the same speed, but of wavelength 2.6 m ?

Ans : COMP 2021

(i) $f = 256\,Hz,\ \lambda = 1.3\,m,\ v = ?$

Using $v = f\lambda$, we have

$$v = 256 \times 1.3$$

$$= 332.8\,ms^{-1}$$

(ii) He will hear a dull sound as the frequency of the sound wave of wavelength 2.6 m will be half the frequency (256/2 = 128 Hz) of the sound of wavelength 1.3 m.

199. The ratio of amplitude of two waves is 3 : 4. What is the ratio of their :

(i) loudness ?

(ii) frequencies ?

Ans : MAIN 2016

(i) $\frac{L_1}{L_2} = \left(\frac{3}{4}\right)^2 = \frac{9}{16}$

(ii) 1 : 1

200. The ratio of amplitude of two waves of same pitch is 3 : 4. What is the ratio of their:

(a) loudness?

(b) frequencies?

Ans : MAIN 2016

(a) Ratio of loudness of two waves $= 9:16$ as loudness depends upon intensity which is directly proportional to the square of the amplitude.

(b) Ratio of frequencies $= 1:1$ as pitch of a note depends on its frequency.

201. A person standing between two vertical cliffs and 480 m from the nearest cliff shouts. He hears the first echo after 3 s and the second echo 2 s later. Calculate:

(a) The speed of sound.

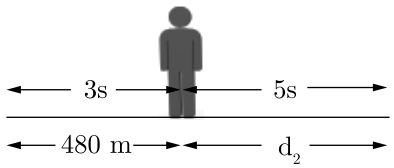
(b) The distance of the other cliff from the person.

Ans : COMP 2015

(a) Speed of sound,

$$\nu = \frac{2d_1}{t_1}$$

$$= \frac{2 \times 480\,m}{3\,s} = 320\,m\,s^{-1}$$



Downloaded from www.pdf.tube

$$f = \frac{v}{\lambda} = \frac{330}{0.01} = 33000\ \text{Hz}$$

No, this cannot be heard by a normal human being.

222. A certain sound has a frequency of 256 hertz and a wavelength of 1.3 m. Calculate the speed with which this sound travels. What difference would be felt by a listener between this sound and another sound travelling at the same speed but of wavelength 2.6 in ?

Ans : MAIN 2006

(i) Given,

$$f = 256\ \text{Hz},\ \lambda = 1.3\ \text{m},\ v = ?$$

$$v = f\lambda = 256 \times 1.3 = 332.8\ \text{ms}^{-1}$$

(ii) In the second case, $f = (332.8/2.6) = 128$ Hz

(iii) This frequency is half the original frequency; therefore, the sound will be flatter or less shrill than the original sound.

223. A radar sends a signal to an aircraft at a distance of 30 km away and receives it back after 2×10^{-4} second. What is the speed of the signal?

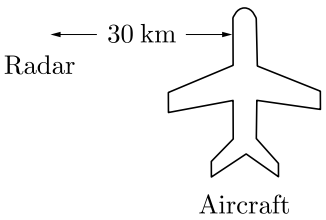
Ans : MAIN 2023

Speed of the signal sent to an aircraft,

$$\nu = \frac{2d}{t}$$

$$= \frac{2 \times 30 \times 1000\ \text{m}}{2 \times 10^{-4}\ \text{s}}$$

$$= 3 \times 10^{8}\ \text{m s}^{-1}$$



224. A radar sends a signal to an aeroplane at a distance 45 km away with a speed of $3 \times 10^{8}\ \text{m s}^{-1}$. After how long is the signal received back from the aeroplane?

Ans : SQP 2014

As we know that,

$$v = \frac{2d}{t}$$

$$t = \frac{2 \times 45 \times 1000}{3 \times 10^{8}}$$

$$= 3 \times 10^{-4}\ \text{s}$$

225. A man standing 25 m away from a wall produces a sound and receives the reflected sound.

(a) Calculate the time after which he receives the reflected sound if the speed of sound in air is $350\ \text{ms}^{-1}$.

(b) Will the man be able to hear a distinct echo? Give a reason for your answer.

Ans : COMP 2023

(a) The time after which the man receives the reflected sound

$$\nu = \frac{2d}{t}$$

$$t = \frac{2d}{\nu} = \frac{2 \times 25\ \text{m}}{350\ \text{ms}^{-1}} = 0.14\ \text{s}$$

(b) Since $0.14\ \text{s} > 0.1\ \text{s}$. Therefore, he will be able to hear a distinct echo.

226. An observer stands at a certain distance away from a cliff and produces a loud sound. He hears the echo of the sound after 1.8 s. Calculate the distance between the cliff and the observer if the velocity of sound in air is 340 m s^{-1}.

Ans : MAIN 2011

Distance between the cliff and the observer,

$$d = \frac{\nu \times t}{2}$$

$$= \frac{340\ \text{m s}^{-1} \times 1.8\ \text{s}}{2}$$

$$= 306.0\ \text{m}$$

227. The ratio of the amplitudes of two waves is 4 : 9. What is the ratio of their intensities?

Ans : MAIN 2012

The intensity of a wave $(I) \propto$ square of its amplitude (A^2)

i.e., $$\frac{I_1}{I_2} = \frac{A_1^2}{A_2^2}$$

Here, $$\frac{A_1}{A_2} = \frac{4}{9}$$

$$\frac{I_1}{I_2} = \frac{(4)^2}{(9)^2} = \frac{16}{81}$$

228. A child hears an echo from a cliff 4 seconds after the sound from a powerful cracker is produced. How far away is the child from the cliff? Take the speed of sound in air as 340 m s^{-1}.

Ans : SQP 2017

We know that, $$d = \frac{\nu \times t}{2}$$

$$= \frac{340\ \text{m s}^{-1} \times 4\ \text{s}}{2}$$

$$= 680\ \text{m}$$

NODIA

14. ELECTRIC ENERGY

Electric energy consumed in a circuit is defined as the total work done in maintaining the current in an electric circuit for a given time, i.e.

$$E = P \times t$$
$$= i^2Rt = \frac{V^2}{R}t = Vit$$

It is measured in joule. But its commercial unit is kWh.
where 1 kWh = 1000 W h = 3.6×10^6 J
1 kW h is the amount of electric energy consumed in an electrical circuit when the electrical appliance of power 1 kW works for 1 hour.
Total energy consumed = $\frac{P \times t}{1000}$ KW h

15. HOUSEHOLD CIRCUITS

Electric fuse is a safety device used in live wire to prevent the electric circuit from overheating due to overloading or short-circuiting. It is a tin-lead alloy wire of low melting point.

15.1 Overloading

Overloading is the process of overheating of the wire due to excess current drawn by all the appliances than the permitted limit for that wire.

15.2 Short-Circuiting

Short-circuiting is the process of overheating which even may cause fire when live wire and the neutral wire comes in contact due to defective or damaged wiring.

15.3 Earthing

Earthing is a process in which earth wire is connected to the metallic body of an appliance to prevent electric shocks, if the live wire touches the metal body.

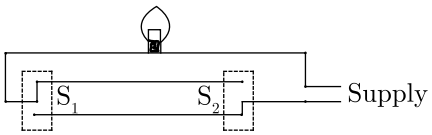
15.4 Colour Coding of Wires

Wires used in electric circuits are usually made of copper. Generally three wires are used in house wiring-live (L), neutral (N) and the third earth wire (E). To identify each wire (live, neutral and earth), a standard colour coding is used for the insulation covering of these wires. Old and new international convention for colour coding for insulation covering is as follows:
Colour coding for connection wires supplying electricity

Types of wire	Colour convention for insulated covers	
	old convention	new convention
Live	Red	Brown
Neutral	Black	Blue
Earth (Ground)	Green	Green/Yellow

15.5 Two-way Switch

Two-way light switches allow one light to be switched ON and OFF independently of the other switch, e.g. a room which has two doorways with a light switch at each door, a bedroom with a main-light switch and another switch within reach of the bed, in a hallway where the lights in the hall upstairs can be switched ON and OFF from a switch downstairs.



15.6 Safety Precautions

Safety precautions are as follows:
(i) A switch should not be touched with wet hands.
(ii) The switch should always be connected in the live wire.
(iii) Always use fuse of appropriate rating in the live wire of the circuit, e.g. a thin fuse wire of low current carrying capacity (≈ 5 A) for electric fan, light, etc., a thick fuse wire of high current carrying capacity (≈ 15 A) for air conditioner, geyser, washing machine, etc.
(iv) Electrical appliances should be properly earthed.

16. MAGNETIC EFFECT OF A CURRENT

An electric current passed in a straight conductor produces a magnetic field around it in a plane perpendicular to the current. The magnetic field lines due to a straight current carrying conductor are circular with their centres on the wire carrying current.

17. RIGHT HAND GRIP RULE

Grasp the current carrying wire in your right hand with the thumb in the direction of the current. The direction of the curled fingers gives

Click Here to Buy book on Amazon

233. Figure 1 shows a large tank of water.

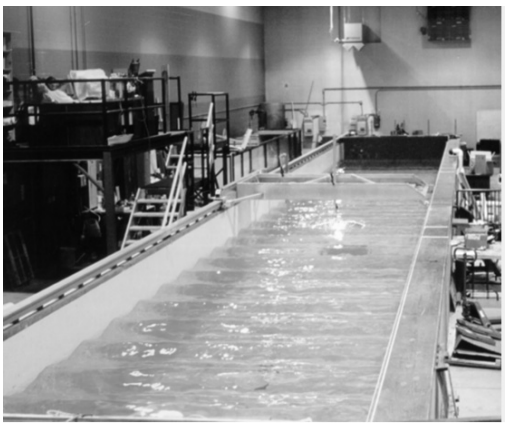


Figure 1

The tank of water is used to study water waves.

(i) Water waves are transverse waves. Give another example of a transverse wave.

(ii) Figure 2 shows a side view of part of the tank.

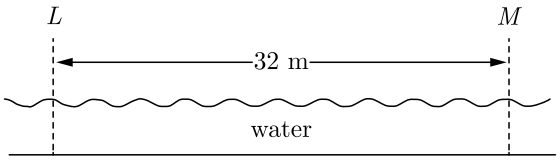


Figure 2

A water wave is moving from L to M. Calculate the wavelength of the wave.

(iii) A technician stands at the side of the tank. He counts the peaks of the waves as they pass him. 12 peaks pass the technician in a time of 15 s. Calculate the frequency of the wave.

Ans :

(i) radio wave
microwave

(ii) $\text{Wavelength} = \dfrac{\text{length between } LM}{\text{Number of waves}}$

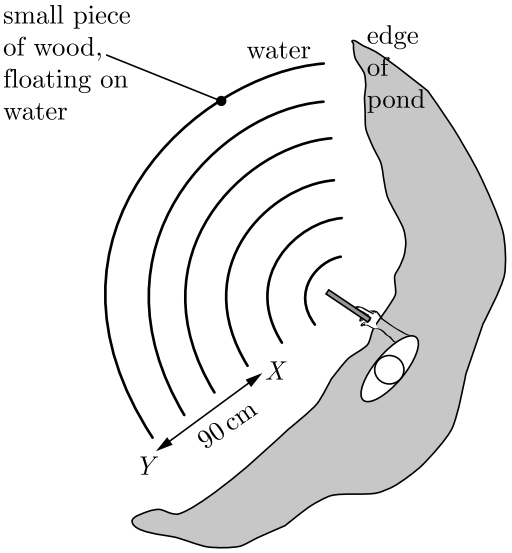
$= \dfrac{32}{10} = 3.2 \text{ m}$

(iii) $\text{Frequency} = \dfrac{\text{Number of peaks}}{\text{time}}$

$= \dfrac{12}{15}$

$= 0.8 \text{ Hz}$

234. Figure shows a view from above of a person standing at the edge of a pond, dipping the end of a stick up and down in the water. Some of the wavefronts that spread out are shown.



(i) How many wavelengths are there between X and Y ?

(ii) The distance from X to Y is 90 cm. Calculate the wavelength of the waves.

(iii) The speed of the waves is affected by the depth of the water.

1. Describe the shape of the wavefronts, as seen from above.
2. What does the shape of the wavefronts tell you about the depth of the pond? Give a reason for your answer.

Ans :

(i) 6

(ii) $\text{Wavelength} = \dfrac{\text{Distance between X and Y}}{\text{number of waves}}$

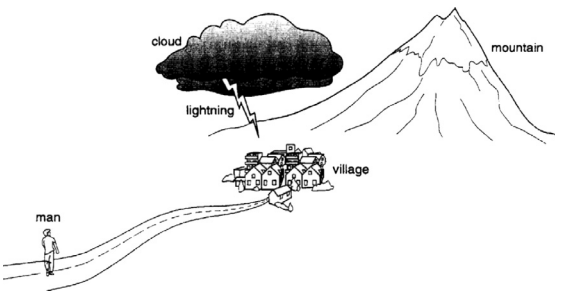
$= \dfrac{90}{6}$

$= 15 \text{ cm}$

(iii) 1. arcs of circles

2. the pond has a constant depth because it travels at the same speed in all directions

235. A man is watching a thunderstorm which is directly over a village. Some distance behind the village is a mountain.



Downloaded from www.pdf.tube

CHAPTER 6

ELECTRICITY AND MAGNETISM

NODIA

SUMMARY

1. CHARGE

The physical characteristic of matter that causes it to feel a force when exposed to an electromagnetic field is called electric charge.

The amount of charge (q) on any body is always an integral multiple of the charge on an electron (e) i.e.

$$q = ne$$

Value of the charge on an electron is -1.6×10^{-19} C

2. ELECTRICITY

The amount of flow charge through any cross-sectional area of a conductor in unity time is called electric current.

or

Electric current is the rate of flow of charge, i.e.,

$$\text{Electric current,} \quad (i) = \frac{\text{Charge}\,(q)}{\text{Times}\,(t)}$$

Its unit is ampere represented by A. It is a scalar quantity.

3. ELECTROSTATIC POTENTIAL

Electrostatic potential is defined as the amount of work done in bringing a unit positive charge from infinity to that point in the vicinity of a charge.

Electrostatic potential determines the direction of flow of charge when a charged body is kept in contact with another body.

In between any two points of a conductor or two bodies, charge flows as long as there is a difference in potential.

4. POTENTIAL DIFFERENCE

Potential difference between two points is equal to the amount of work done in carrying a charge from one point to another.

Potential difference,

$$(V) = \frac{\text{Work done}\,(W)}{\text{Charge moved}\,(q)}$$

It is a scalar quantity. Its unit is volt.

The potential difference between two points is said to be 1 volt if 1 joule of work is done in moving 1 coulomb of charge from one point to another.

$$1\ \text{V} = \frac{1\text{J}}{1\text{C}}$$

To measure the potential difference between two points voltmeter is connected in parallel to those points whereas to measure the current, ammeter is connected in series.

5. CELL/BATTERY

In a cell/battery, chemical energy changes into electrical energy. Conventional direction of the current is taken from positive terminal of a cell to the negative terminal through the outer circuit while the electrons flow in a direction opposite to the flow of conventional current. The electron flow gives the direction of electronic current.

6. CONDUCTORS

Materials that transfer or conduct electric charges are called conductors. e.g. metals (like silver, brass, copper, iron etc.), earth, human body, etc.

7. INSULATORS

Materials which are unable to transfer or conduct electric charges are called insulators. e.g. wood, glass, plastic, air, rubber, wax, hydrogen, oxygen, sulphur, etc.

8. SEMICONDUCTOR

Semiconductors are materials which have a conductivity between conductors (generally metals) and non-conductors or insulators (such as ceramics). Semiconductors can be compounds, such as gallium arsenide, or pure elements, such as germanium or silicon. Physics explains the theories, properties and mathematical approach related to semiconductors.

Gallium arsenide, germanium and silicon are some of the most commonly used semiconductors. Silicon is used in electronic circuit fabrication and

Ans :

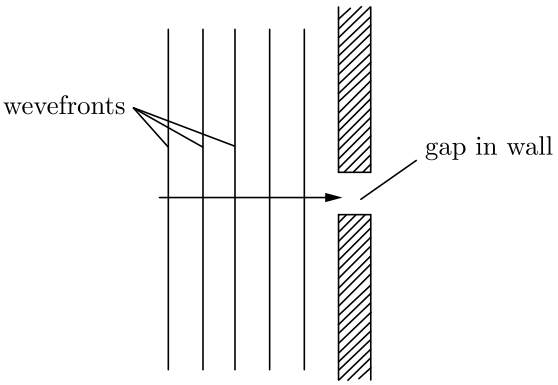
(i) Sound which is above the frequency of 20000 Hz is known as ultrasound. Most likely humans cannot hear the ultrasonic sound but many animals such as dogs, bats, monkeys, etc. can hear ultrasound.

(ii) Speed of ultrasound

$$= \frac{\text{Distance between dog and man}}{\text{Time taken}}$$

$$= \frac{140}{0.42} = 330 \text{ m/s}$$

239. Figure shows water wavefronts which are approaching a small gap in a wall which divides two stretches of water of the same depth. The diagram is drawn to scale.



(i) The waves moving towards the wall have a wavelength of 1.6 m and a frequency of 0.80 Hz. Calculate the speed of these water waves.

(ii) State the wavelength and frequency of the waves after they have passed through the gap in the wall.

Ans :

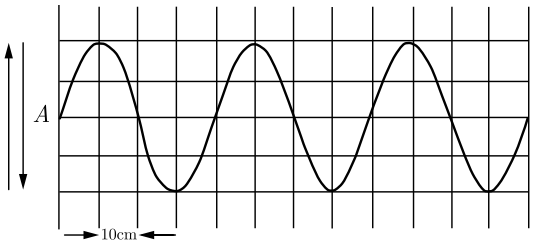
(i) Velocity = frequency × wavelength

$= 0.8 \times 1.6$

$= 1.3$ m/s

(ii) (a) 1.6 m
(b) 0.8 Hz

240. The diagram shows a transverse wave on a piece of thick string. The wave is produced by a person holding the end, A, of the string and moving it up and down. The end A moves up and down five times in 2 s. The wave moves to the right past a grid, which is marked with 10 cm × 10 cm squares.



(i) What is meant by a transverse wave.

(ii) Use the diagram to calculate the wave's:
(a) amplitude
(b) wavelength.

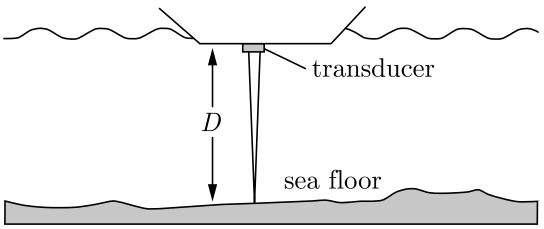
Ans :

(i) Transverse waves are those in which particles in the wave vibrate perpendicular to the direction of propagation of a wave.

(ii) (a) Amplitude of the wave is the height from the central position of the rope i.e. 20 cm
(b) The wavelength is the length of one complete oscillation:

$= 4 \times 10 \text{ cm} = 40 \text{ cm}$

241. A transducer can transmit and detect ultrasonic waves. Figure shows ultrasonic waves transmitted by the transducer on the bottom of a ship.



The waves reflect off the sea floor and are received back at the transducer. The waves travel at 1500 m / s. The time between transmission and reception is 48 milliseconds. Calculate the depth of water, D, shown in Figure.

Ans :

Depth of water $D = \frac{1}{2} v \times t$

$= \frac{1}{2} \times 1500 \times 0.048$

$= 36$ m

www.nodia.in

Click Here to Buy book on Amazon

229. The wavelength of a sound wave is 66 m. Calculate the frequency of the wave, if the velocity of sound is 330 m s^{-1}. Would this sound be audible to the human ear?

Ans : COMP 2001

Given, $\lambda = 66\text{ m};\ v = 330\text{ ms}^{-1};\ \nu = ?$

We know that, $v = \nu\lambda$

$$\nu = \frac{v}{\lambda}$$

$$= \frac{330\text{ m s}^{-1}}{66\text{ m}} = 5\text{ Hz}$$

It will not be audible to the human ear because the frequency of this sound 5 Hz is below the audible frequency range 20 Hz to 20000 Hz.

230. Two strings of a guitar are of lengths 40 cm and 20 cm, such that they are made from same material and are of same thickness and under same tension. If the frequency of longer wire is 250 Hz, find the frequency of smaller wire.

Ans : SQP 2020

According to the law of length

$$\frac{f_1}{f_2} = \frac{l_1}{l_2}$$

$$\frac{250\text{ Hz}}{f_2} = \frac{20\text{ cm}}{40\text{ cm}}$$

$$f_2 = \frac{250 \times 40}{20} = 500\text{ Hz}$$

CASE BASED QUESTION

231. The below picture shows a mother pushing her daughter sitting on a swing. The swing is going through the positions A, B, C where A and C are extreme positions and B is the mean position.

(i) Which is the right position i.e. at A, B or C, for the mother to give a constant periodic push to the swing every time in the forward direction to increase the amplitude of the swing?

(ii) Name the phenomenon involved in this.

(iii) Explain with this example how this phenomenon helps to increase the amplitude of the swing.

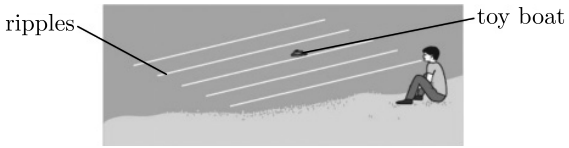
Ans :

(i) At A

(ii) Resonance

(iii) The natural frequency of the swing will match the frequency of the force-applied by mother this will increase the amplitude.

232. Figure shows a student sitting on the shore of a lake watching ripples on the surface of the water moving past a toy boat.



The student has a stopwatch.

(i) Describe how the student could determine the frequency of the ripples on the lake.

(ii) The speed of a water wave is 1.5 m/s. The frequency of the wave is 0.70 Hz. Calculate the wavelength of this wave.

(iii) Water waves are transverse waves. Describe the difference between transverse waves and longitudinal waves.

Ans :

(i) $\text{Frequency} = \frac{\text{number of waves}}{\text{time}}$

(ii) $v = f \times \lambda$

$$1.5 = 0.7 \times \lambda$$

$$\lambda = \frac{1.5}{0.7} = 2.14\text{ m}$$

(iii)

Longitudinal	**Transverse**
The medium moves in the same direction of the wave	The medium is moving perpendicular to the direction of wave
It acts in one dimension	It acts in two dimensions

NODIA

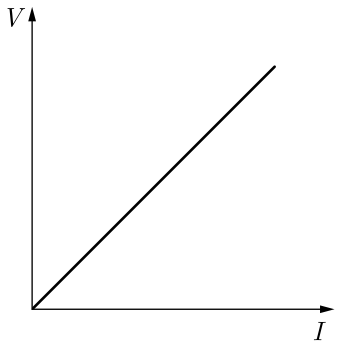
gallium arsenide is used in solar cells, laser diodes, etc.

9. SUPERCONDUCTORS

The electrical resistivity of many metals and alloys drops suddenly to zero on cooling their specimen to a sufficiently low temperature called the critical temperature (T_c). This phenomenon is called superconductivity and the materials showing such a behaviour are called superconductors.

10. OHM'S LAW

According to Ohm's law, at a constant temperature, the current flowing in a conductor is directly proportional to the potential difference across its ends,



$$V \propto I$$

$$V = IR$$

The slope of $V-I$ graph gives the resistance of the conductor/resistor.

1 ohm is the resistance of a conductor through which 1 ampere current flows when the potential difference of 1 volt is applied across its ends. Some conductors obey Ohm's law, therefore known as Ohmic resistors while some do not, known as Non-Ohmic resistors.

11. RESISTANCE

Resistance is property of the material due to which it opposes the flow of electric current through it. Resistances can be combined in series or in parallel.

11.1 Series Combination

Equivalent resistance of the resistors connected in series is equal to the sum of the individual resistances, i.e.,

$$R_s = R_1 + R_2 + R_3$$

In series combination of resistors, same current flows through each resistor since there is only one path for current flow but the potential difference between their ends are different according to their resistances.

11.2 Parallel Combination

Equivalent resistance of the resistors connected in parallel is equal to the sum of the reciprocal of the individual resistances, i.e.,

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

In parallel combination of resistors, the voltage across each resistor is same but the current divides since there are as many paths for current as the number of resistances.

12. INTERNAL RESISTANCE OF A CELL

Internal resistance of a cell is defined as the resistance offered by electrolyte and electrodes of a cell when electric current passes through it.

It depends upon

(i) nature of electrodes

(ii) nature of electrolyte

(iii) area of the electrodes immersed in the electrolyte

(iv) distance between the electrodes.

12.1 Terminal Potential

Terminal potential difference of a cell is defined as the potential difference between the two electrodes of a cell in a closed circuit.

12.2 Electromotive Force

Electromotive force of a cell is defined as the maximum potential difference between the two electrodes of a cell when the cell is in open circuit.

13. ELECTRICAL POWER

According to Joule's law of heating the amount of heat produced in a conductor is directly proportional to the (i) square of the current flowing through the conductor, (ii) resistance of the conductor and (iii)time for which the current is passed, i.e., $H = i^2Rt$. H is also expressed as Vit or $\frac{V^2}{R}t$. It is measured in joule.

Electric power is the rate at which work is done in maintaining the current in an electric circuit, i.e.

$$P = \frac{W}{t} = Vi = \frac{V^2}{R} = i^2R$$

It is measured in watt or J/s.

1 watt is the power of an electric circuit, if 1 ampere current flows in it against a potential difference of 1 volt.

Downloaded from www.pdf.tube

(i) Thunder is created at the same time as the lightning flash but, after the man sees a lightning flash, he has to wait a short time before he hears the thunder. Why is there this delay?

(ii) When he listens carefully, the man realises that, for each lightning flash, he can hear a loud sound of thunder followed by a quieter one. After studying Figure, explain why he hears two sounds for each lightning flash.

(iii) The man measures the time between seeing a flash of lightning over the village, and hearing the first sound of thunder. The time is 4 s. The speed of sound in air is 330 m/s. How far away is the village?

Ans :

(i) The lightning flash before we can hear thunder because, the speed of light is more than speed of sound.

(ii) because of the echo

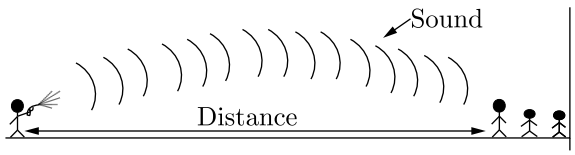
(iii) $\text{speed} = \frac{\text{distance}}{\text{time}}$

$\text{Distance} = \text{speed} \times \text{time}$

$= 330 \times 4$

$= 1320 \text{ m}$

236. Four students and their teacher do an experiment to measure the speed of sound in air. The teacher stands at a distance and fires a starting pistol into the air. The students see the flash when the pistol is fired. They measure the time from when they see the flash to when they hear the bang. A student drew a diagram of the arrangement as shown in Figure.



The students obtained a value of 240 m/s for the speed of sound. The accepted value, in a science data book, is 343 m/s.

(i) Calculate the difference between the students' value and the accepted value as a percentage of the accepted value.

(ii) When the distance was 100 m, the students measured the following times:
0.43 s 0.35 s 0.50 s 0.38 s
Explain why their times vary so much.

Ans :

(i) Percentage difference

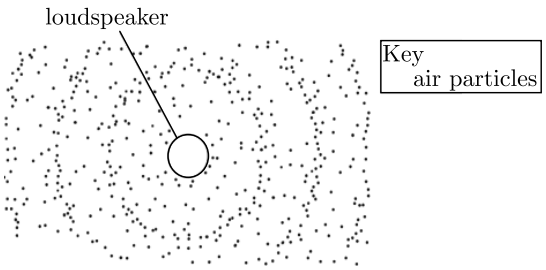
$= \frac{\text{Obtained value} - \text{accpted value}}{\text{accpted value}} \times 100$

$= \frac{240 - 343}{343} \times 100$

$\approx 30\,\%$

(ii) Students are at different distances from the bang of pistol. Therefore measured value of time is different.

237. Figure represents a sound wave coming from a loudspeaker and shows the effects on particles of the air at one instant in time.

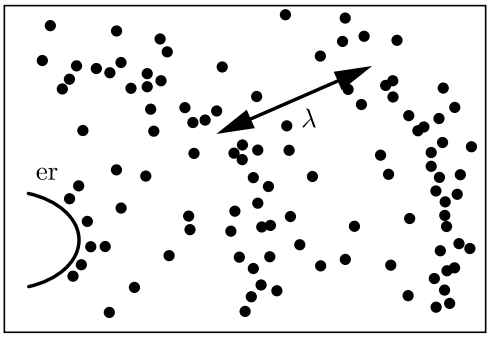


(i) Draw and label a distance of one wavelength in Figure.

(ii) Describe the motion of the particles as the wave travels through the air.

Ans :

(i)



(ii) The particles of the medium vibrate backwards and forwards parallel to direction of energy transfer about mean positions

238. A man uses a dog whistle to call his dog. The whistle uses ultrasound.

(i) The dog can hear the whistle but the man cannot. Explain why the dog can hear the whistle but the man cannot hear the whistle.

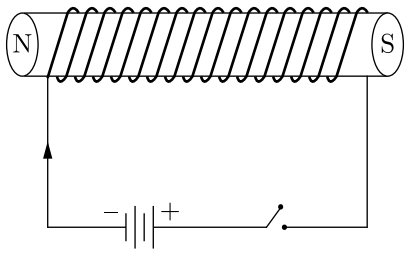
(ii) The dog is 140 m away from the man. The ultrasound takes 0.42 s to travel from the man to the dog. Calculate the speed of ultrasound. State the unit.

NODIA

the direction of magnetic field with the finger tips pointing along magnetic field. It can also be used in other way also, i.e. if the curled fingers of the right hand represent the direction of the current, the thumb gives the direction of the magnetic field.

18. SOLENOID

A solenoid (cylindrical coil wound with 500 or more turns of insulated copper wire) is connected in series with 6 V or 12 V battery and switch as shown in the figure. A steel bar is placed inside the coil and the current is switched ON and OFF. On removing and testing the bar, it is found to be magnetised using the magnetic effect of a current.



Magnetisation of a bar by an electrical method

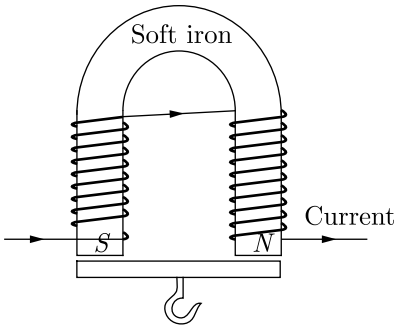
The polarity of the magnet depends on the direction of flow of current which can be determined by end on rule, i.e. on looking at the end of the bar, if the current is flowing in a clockwise direction that end will be a South pole, if anti-clockwise, it will be a North pole.

1. Inside a current carrying solenoid, the magnetic field is uniform and parallel to the axis and outside the solenoid, the field is similar to that produced by magnet.
2. If electric current is passed in a solenoid with a core of magnetic material like soft iron, the core becomes an electromagnet.
3. The strength of an electromagnet can be increased by
   (i) increasing the current
   (ii) increasing the number of turns in the coil
   (iii) using a soft iron core.

19. U-SHAPED ELECTROMAGNET

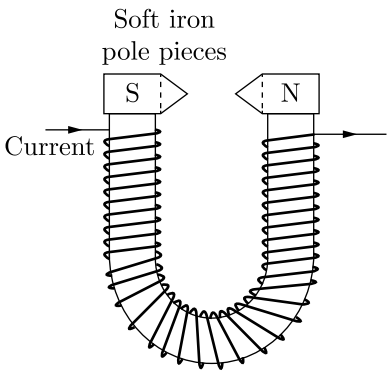
Sturgeon's electromagnet was made of a bar of soft iron bent into a U-shape and having coils of insulated copper wire wound in opposite directions on the two arms.

FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP



William Sturgeon's Electromagnet

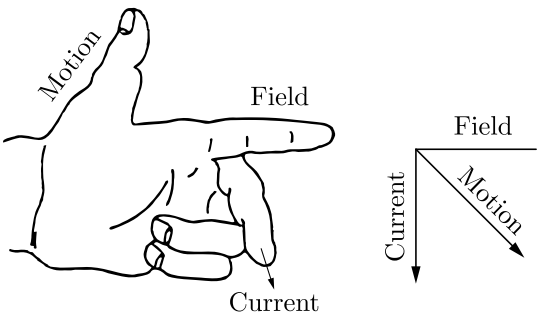
Michael Faraday in England and Joseph Henry in America also made similar electromagnets which were provided with soft iron pole pieces for the purpose of concentrating the magnetic flux in a small gap.



Michael Faraday's Electromagnet

20. FLEMING'S LEFT HAND RULE

According to Fleming's left hand rule, stretch your forefinger, the middle finger and the thumb of the left hand mutually perpendicular to one another such that the forefinger points in the direction of magnetic field (B), the middle finger in the direction of current i, the thumb will point in the direction of force experienced by the conductor.



21. ELECTROMAGNETIC INDUCTION

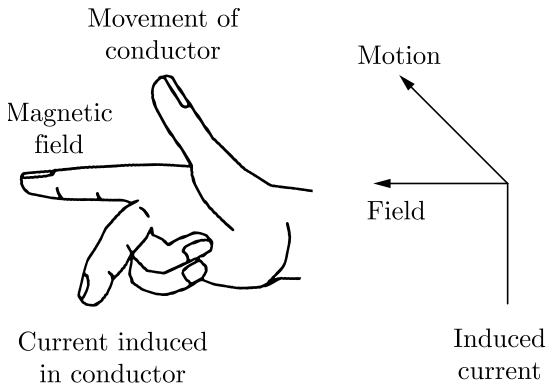
Electromagnetic induction is the phenomenon

Click Here to Buy book on Amazon

due to which e.m.f. is induced in a closed loop/ circuit when there is a relative motion between a closed loop/circuit and a magnet. In this closed loop/circuit, the direction of induced current is given by Fleming's right hand rule.

21.1 Fleming's Right Hand Rule

According to Fleming's right hand rule stretch first finger, central finger and the thumb of your right hand in three mutually perpendicular directions such that first finger points in the direction of magnetic field, thumb points towards the direction of motion of the conductor, the direction of central finger gives the direction of induced current set up in the conductor.



22. DYNAMO OR GENERATOR

A dynamo or generator converts mechanical energy of rotation of the coil into electrical energy. DC dynamo gives direct current and a.c. dynamo gives alternating current.

23. DC MOTOR

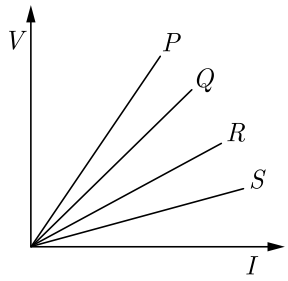
DC motor converts electric energy (direct current) into mechanical energy of the rotation of the coil.

24. TRANSFORMER

Transformer is a device used to step-up or step-down the alternating voltage. The transformer which increases the alternating voltage is called a step-up transformer, on the other hand which decreases the alternating voltage, is called a step-down transformer. It is based on the principle of electromagnetic induction. Alternating current (A.C.) is transmitted to the users along transmission line at higher voltage to reduce the loss of electrical energy during transmission.

MULTIPLE CHOICE QUESTION

1. The graph of voltage vs current for four different materials is shown below.



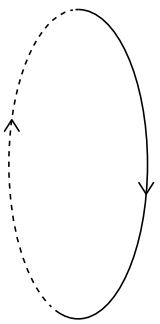
Which of these four materials would be used for making filament of a bulb?

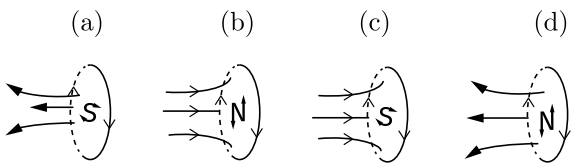
(a) Q (b) S
(c) P (d) R

Ans : SQP 2025

The filament of a bulb should produce a high heating effect so its resistance should be high. From the graph, slope of line for substance P is the greatest hence, resistance of P is highest. So, substance P is most suitable for making the filament of a bulb.
Thus (c) is correct option.

2. Current is flowing through a coil as shown in the figure. Which one of the given figures will correctly depict the magnetic polarity and the direction of the lines of force along the axis of the coil.





Ans : SQP 2025

Thus (c) is correct option.

NODIA

3. According to the old convention, the colour of the earth wire is:
(a) black (b) green
(c) yellow (d) red

Ans : SQP 2025

According to the old convention, an electrical circuit cable had three wires.
1. The live wire is red.
2. The neutral wire's color is black.
3. The earth wire's color is green.

Thus (b) is correct option.

4. The specific resistance of a conductor depends on its
(a) length (b) material
(c) area of cross section (d) radius

Ans : MAIN 2024

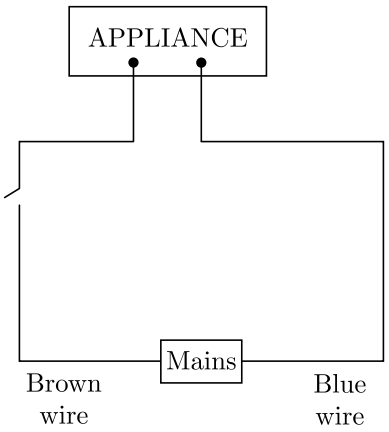
Specific resistance of a wire is an intrinsic property of the material of wire, so it depends only on the material of the wire but not on the dimensions of the wire.
Thus (b) is correct option.

5. The potential difference between terminals of a cell in a closed electric circuit is
(a) terminal voltage (b) electro motive force
(c) voltage drop (d) none of these

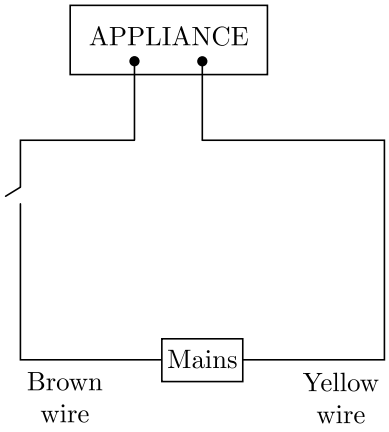
Ans : MAIN 2024

Potential difference between terminals of a cell, in open circuited condition, is termed as electromotive force. Potential difference between terminals of a cell, in closed circuited condition is termed as terminal voltage.
Thus (a) is correct option.

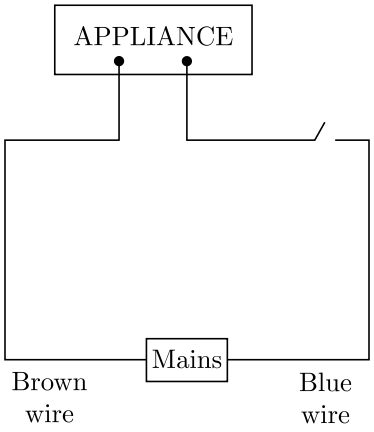
6. Identify the option that displays the correct wiring with correct colour code
(a)



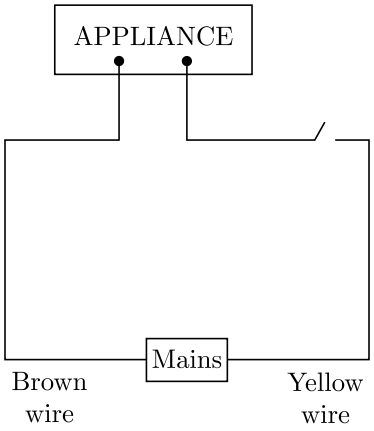
(b)



(c)



(d)



Ans : MAIN 2024

From mains, blue wire (NEUTRAL) should directly reach the appliance and the brown wire (LIVE) should reach the appliance through a switch.
Thus (a) is correct option.

NODIA

$$= \frac{1.2}{2} = 0.6 \text{ A}$$

$$E - V = Ir$$

$$1.5 - 1.2 = 0.6r$$

$$r = \frac{0.3}{0.6} = 0.5\Omega$$

Thus (c) is correct option.

30. An electric heater draws a current of 5 A, when connected to 220 V mains. Calculate the resistance of its filament.

(a) 13 Ω (b) 37 Ω
(c) 50 Ω (d) 44 Ω

Ans : COMP 2002

Given,

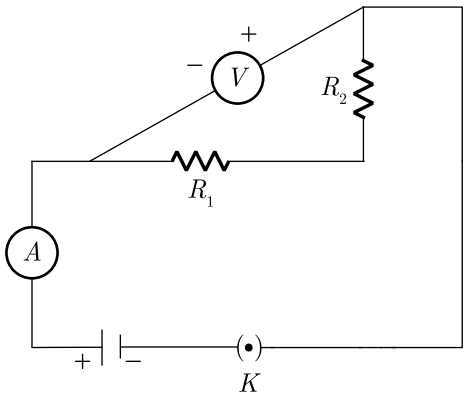
$$I = 5 \text{ A}, V = 220 \text{ Volt}$$

As we know that,

$$R = \frac{V}{I} = \frac{220}{5} = 44\Omega$$

Thus (d) is correct option.

31. I. The resistors R_1 and R_2 have not bean correctly connected in parallel.
II. The voltmeter has not been correctly connected in the circuit.
III. The ammeter and the key have not been correctly connected in the circuit.



Out of these three, the actual fault in this circuit is are

(a) Both I and II
(b) Both II and III
(c) Only II
(d) Only I

Ans : MAIN 2008

Only statement I because resistances are connected in series not in parallel.
Thus (d) is correct option.

32. A nichrome wire of length l and area of cross-section $\frac{a}{4}$ has a resistance R. Another nichrome wire of length $3l$ and area of cross-section $\frac{a}{2}$ has a resistance of R_1. Find the ratio of $R_1 : R$.

(a) 1 : 2 (b) 2 : 2
(c) 4 : 2 (d) 3 : 2

Ans : SQP 2012

$$\text{Specific resistance, } \rho = \frac{RA}{l}$$

As both the wire are made of same material, have same specific resistance

$$= \frac{R\frac{a}{4}}{l} = \frac{R_1\frac{a}{2}}{3l}$$

$$\frac{R}{4} = \frac{R_1}{6}$$

$$\frac{R_1}{R} = \frac{6}{4} = \frac{3}{2}$$

$$R_1 : R = 3 : 2$$

Thus (d) is correct option.

33. Which of the following an ohmic resistance ?

(a) Manganin wire (b) Filament of a bulb
(c) Carbon are light (d) Diode valve

Ans : COMP 2013

Materials and components that obey Ohm's law are described as "ohmic". Manganin wire is ohmic.
Thus (a) is correct option.

34. When the current is drawn from a cell in a closed circuit, the potential difference between the terminals of cell is called :

(a) Potential difference
(b) E.m.f.
(c) Terminal voltage
(d) Both (a) and (b)

Ans : MAIN 2017

When the current is drawn from a cell in a closed circuit, the potential difference between the terminals of cell is called terminal voltage.
Thus (c) is correct option.

35. A current of 0.2 A flows through a conductor of resistance 4.5 Ω. Calculate potential difference at the ends of conductor.

(a) 0.3 V (b) 0.7 V
(c) 0.10 V (d) 0.9 V

Ans : SQP 2006

Given, $I = 0.2 \text{ A}, R = 4.5\Omega$

Potential difference $V = IR$

Downloaded from www.pdf.tube

14. Kilowatt hour and kilowatt are :
(a) SI units of power and electric energy
(b) commercial units of electric energy and power
(c) commercial units of power and electric energy
(d) SI units of electric energy and power

Ans : SQP 2008

A kilowatt is a unit of power (rate of flow of energy per unit of time). A kilowatt hour is a unit of energy.
Thus (b) is correct option.

15. A bulb of resistance 4000 is connected to 200 V mains. Calculate the magnitude of current.
(a) 0.5 A (b) 0.3 A
(c) 0.9 A (d) 0.10 A

Ans : MAIN 2005

Given, $R = 400\Omega,\ V = 200\text{V}$

$$I = \frac{V}{R} = \frac{200}{400} = 0.5 \text{ A}$$

Thus (a) is correct option.

16. In a parallel circuit
(a) the equivalent resistance of all resistors is more than any of the individual resistors
(b) potential difference across all resistors is same
(c) current flowing through all resistors is same
(d) none of the above

Ans : SQP 2003

In a parallel combination of resistances, potential difference is same across each resistance.
This is because in a parallel combination, the ends of each resistor are connected to the ends of the same source of potential.
Thus (b) is correct option.

17. Which of the following statement is incorrect regarding to step-down transformer?
(a) number of turns in primary are more than the secondary coil
(b) the primary coil is more heavily insulated as compared to secondary coil
(c) the primary coil is thinner as compared to the secondary coil
(d) the primary coil is thicker as compared to secondary coil

Ans : COMP 2002

The primary coil is thicker as compared to secondary coil.
Thus (d) is correct option.

18. The graph between voltage and current for a conductor is a straight line. The slope of the graph represents :
(a) electric potential (b) resistance
(c) resistivity (d) none of these

Ans : MAIN 2010

The slope of the V-I graph represents the resistance of the material
Thus (b) is correct option.

19. On reversing the direction of current in a wire the magnetic field produced by it
(a) get reversed in direction
(b) remains unchanged in strength and direction
(c) increases in strength
(d) decreases in strength

Ans : COMP 2008

On reversing the direction of current in a wire, the magnetic field produced by it get reversed in direction because magnetic field

$$= \frac{\mu_0}{4\pi}\frac{Idl\sin\theta}{r^2}$$

The direction of magnetic field is perpendicular to both Idl and r.
Where, I is the current flowing through a conductor of length dl, μ_0 = permeability in free space

$$= 4\pi \times 10^{-7} \text{ Tm/A}$$

Thus (a) is correct option.

20. In a step down transformer :
(a) number of turns in primary coil are less than the secondary coil.
(b) the primary and secondary coils are wound on separate steel cores
(c) number of turns in primary coil are more than the secondary coil.
(d) number of turns in primary coil are equal to the secondary coil

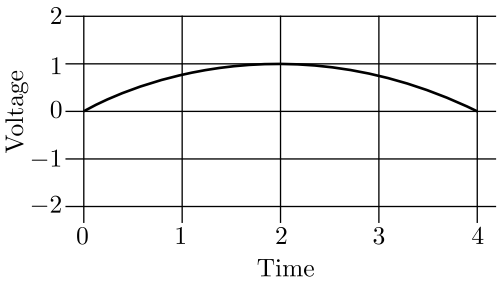
Ans : SQP 2016

In a step-down transformer, the number of turns of the primary coil are more than the number of turns of the secondary.
Thus (a) is correct option.

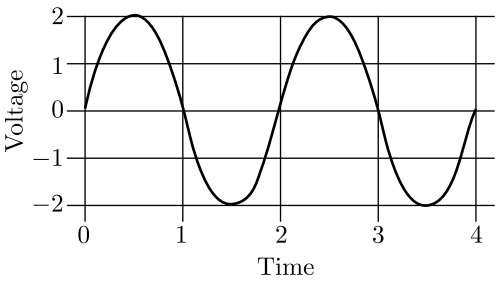
21. A simple AC generator produces a voltage that varies with time as shown below :
Which graph shows how the voltage varies with time when the generator rotates at twice the original speed ?

NODIA

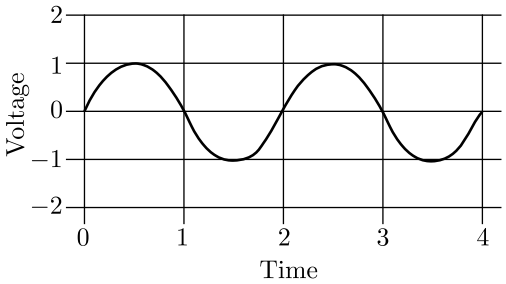
(a)



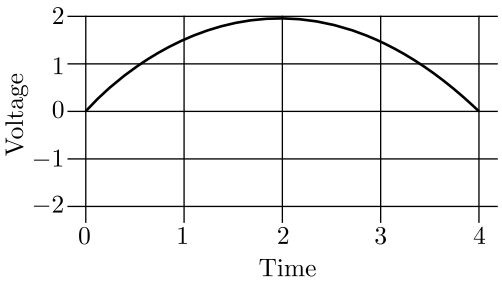
(b)



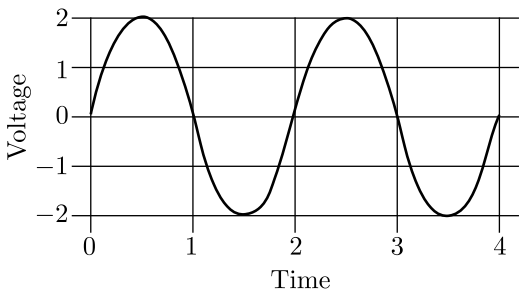
(c)



(d)



Ans : COMP 2014



Since, the speed is doubled, the amplitude of AC voltage is doubled and the period of the voltage is halved.
Thus (b) is correct option.

22. The power of a d.c. motor can be increased :
(a) by laminating its soft iron core
(b) by increasing the strength of current flowing through it
(c) by increasing number of turns in its coil
(d) all of these

Ans : COMP 2021

The power of the DC motor increases by increasing the torque developed by the shaft/rotor which in turn depends on the current in direct proportion. As the torque on the coil with the increase of cross-sectional area and introducing soft iron core, these are also the factors that effects the power of the motor in direct proportion.
Thus (d) is correct option.

23. A geyser is rated 2000 W and operates 2 hours a day on 200 V mains. Calculate the monthly bill for running the geyser when energy costs 1.90 per kWh.
(a) 128 (b) 328
(c) 228 (d) 428

Ans : SQP 2013

Power of geyser $P = 2000$ W

$$= \frac{2000}{1000} = 2 \text{ kW}$$

$t = 2$ hours per day

Energy consumed per day

$$E = P \times t$$

$$= 2 \times 2 = 4 \text{ kWh}$$

Energy consumed in 30 days

$$= 4 \times 30 = 120 \text{ kWh}$$

Cost of 120 kWh $= 120 \times 1.90 = 228$

Hence, Monthly bill $= 228$
Thus (c) is correct option.

24. A soldering iron draws an energy of 43200 J in 4 min, when the current flowing through its element is 6 A, calculate the resistance of its heating element.
(a) 2 Ω (b) 3 Ω
(c) 8 Ω (d) 5 Ω

Ans : MAIN 2000

Given,

Energy drawn $E = 43200$ J,

$t = 4$ min. $= (4 \times 60)$ s

Now, $I = 6$ A

Click Here to Buy book on Amazon

$$R = \frac{E}{I^2 t}$$
$$= \frac{43200}{6 \times 6 \times (4 \times 60)}$$
$$= 5\,\Omega$$

Thus (d) is correct option.

25. Calculate potential difference at the ends of a power source which, supplies current to a 4 ohm resistance wire for 20 minutes and raises temperature of 400 g of water through 20°C.

(a) 2.00 V (b) 3.80 V
(c) 10.5 V (d) 5.60 V

Ans : SQP 2007

Given, $R = 4\Omega$

Time = (20×60) second

Heat required to raise the temperature of water through 20°C

$$Q = E = mcT$$
$$m = 400 \text{ g}$$
$$c = 4.2\,\text{J/g}\,^\circ\text{C}^{-1}$$
$$T = 20^\circ$$

Also, $t = 20$ min

$$t = 2 \times 60 \text{ sec.}$$
$$\frac{V^2 t}{R} = mcT$$
$$\frac{V^2 \times (20 \times 60)}{4} = 400 \times \frac{42}{10} \times 20$$
$$V^2 = \frac{400 \times 42 \times 20 \times 4}{10 \times 20 \times 60}$$
$$= 112$$
$$V = \sqrt{112} \text{ Volt}$$
$$= \sqrt{16 \times 7} = 4\sqrt{7} \text{ volt}$$
$$V = 10.5 \text{ Volt}$$

Thus (c) is correct option.

26. An electric heater of power 1000 W, draws a current of 5.0 A. Calculate the line voltage.

(a) 800 V (b) 380 V
(c) 560 V (d) 200 V

Ans : MAIN 2018

Power of heater $P = 1000$ W,

$$I = 5.0 \text{ A}$$
$$\text{Voltage, V} = \frac{P}{I} = \frac{1000}{5} = 200 \text{ Volt}$$

Thus (d) is correct option.

27. In a three pin plug the live pin in :

(a) thinner and is toward left
(b) thicker and is towards right
(c) thicker and is towards left
(d) thinner and is towards right

Ans : COMP 2011

Three cylindrical pins are present in the three-pin plug. They are the live pin, neutral pin, and earth pin. The live pin is thinner and is toward the right.

Thus (b) is correct option.

28. A bulb has a resistance of 20Ω and the potential difference across its terminals is V. If the bulb is used for t seconds then energy consumed by the bulb is :

(a) $\frac{V}{20} \times t$ (d) $\frac{V \times t^2}{20}$
(c) $\frac{V^2}{20} \times t$ (d) $V \times t = 20$

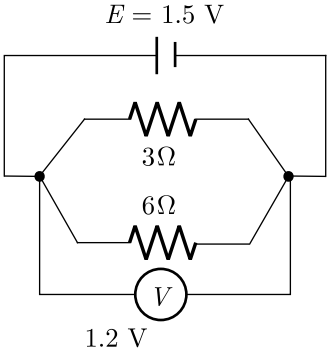
Ans : SQP 2019

Resistance of bulb, $R = 20\Omega$

$$W = \frac{V^2}{R} t$$
$$= \frac{V^2}{20} t$$

Thus (c) is correct option.

29. Study the circuit diagram in figure and hence, calculate the internal resistance of cell.



(a) 0.3 Ω (b) 2.8 Ω
(c) 0.5 Ω (d) 3.0 Ω

Ans : MAIN 2015

Since, 3 Ω and 6 Ω are in parallel and its equivalent resistance is given by

Hence, $R = \frac{3 \times 6}{(3+6)} = 2\Omega$

$$I = \frac{V}{R}$$

NODIA

7. The graph plotted for potential difference (V) against current (I) for ohmic resistors is
(a) a curve passing through the origin
(b) a straight line not passing through origin
(c) a straight line passing through origin
(d) a circle centred at the origin

Ans : SEM-II 2022

The graph between potential difference (V) against current (I) for ohmic resistors is a straight line passing through origin.
Thus (c) is correct option.

8. A main switch in the main distribution board is present in
(a) A live wire
(b) a neutral wire
(c) a live as well as neutral wire
(d) an earth wire

Ans : SEM-II 2022

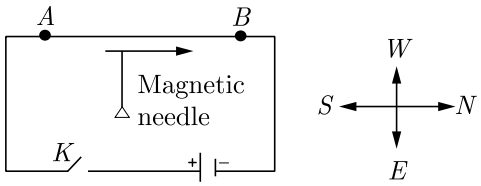
The main switch is connected in the live and neutral wire.
Thus (c) is correct option.

9. A coil wound around a piece of soft iron can become an electromagnet only when
(a) the circuit is open
(b) a magnetic compass is present in the vicinity
(c) a galvanometer is connected to the circuit
(d) a current flows in the circuit

Ans : SEM-II 2022

A coil wound around a piece of soft iron becomes electromagnet only when a current flows in the circuit.
Thus (d) is correct option.

10. A conductor AB is kept along North-South direction of the earth above a magnetic needle as shown below. When the key K is closed, then



(a) the needle will not show any deflection.
(b) the needle will deflect towards East.
(c) the needle will turn in the opposite direction i.e. towards South.
(d) the needle will deflect towards West.

Ans : SEM-II 2022

From the figure we can see that the magnetic needle is kept below the conductor AB which is kept an North-South direction. We can see that the current is in anti-clockwise direction and from the right hand thumb rule the direction of magnetic field will be from West to East. Hence, according to Fleming's left hand rule, the deflection produced will be towards East.
Thus (b) is correct option.

11. Which is not the characteristic of a fuse wire ?
(a) It has high resistance
(b) It has low resistance
(c) It is an alloy of lead and tin
(d) It has low melting point

Ans : COMP 2016

Fuse wire has high resistance such that its temperature increases rapidly, it melts when the current flow exceeds certain limits. Fuse wire has a low melting point which melts around. It is a combination of an alloy of lead and tin.
Thus (b) is correct option.

12. A wire carrying a current is held over a freely suspended magnetic needle, such that the current in the wire flows from south to north. The direction in which the north end of freely suspended magnetic needle will point towards.
(a) West (b) North
(c) South (d) East

Ans : SQP 2013

The direction in which the north end of freely suspended magnetic needle will point towards East.
Thus (d) is correct option.

13. A straight wire lying in a horizontal plane carries a current from North to South. Magnetic field at a point directly below the wire is
(a) West (b) East
(c) North (d) South

Ans : COMP 2012

A straight wire lying in a horizontal plane carries a current from North to South. Magnetic field at a point directly below the wire is towards East according to Ampere's swimming rule or SNOW rule. If current flows from south to North, magnetic field will be towards West but if current flows from North to South, magnetic field will be towards East.
Thus (b) is correct option.

Downloaded from www.pdf.tube

$$V = 0.2 \times 4.5$$
$$= 0.9\text{Volt}$$

Thus (d) is correct option.

36. A cell of e.m.f. 1.8 V is connected to an external resistance of 2 Ω, when potential difference recorded at the ends of resistance is 1.6 V. Calculate the internal resistance of the cell.

(a) 3 Ω (b) 1.30 Ω
(c) 2.8 Ω (d) 0.25 Ω

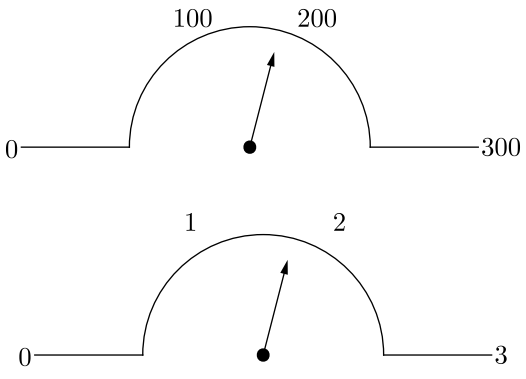
Ans : COMP 2014

$$I = \frac{V}{R}$$
$$I = \frac{1.6}{2} = 0.8 \text{ A}$$

Now, $E - V = Ir$
$$1.8 - 1.6 = 0.8r$$
$$r = \frac{0.2}{0.8} = 0.25\Omega$$

Thus (d) is correct option.

37. The current flowing through a resistor connected in an electric circuit and the potential difference applied across its ends are shown in figure below. The value of the resistance of the resistor is



(a) 10 Ω (b) 5 Ω
(c) 8 Ω (d) 1 Ω

Ans : MAIN 2002

Reading of ammeter in terms of amperes,
$$I = 180 \text{ mA}$$
$$= 0.18 \text{ A}$$
Reading of voltmeter, $V = 1.8$ Volt
Resistance of the resistor, $R = \frac{V}{I} = \frac{1.8}{0.18}$
$$= \frac{180}{18} = 10\Omega$$

Thus (a) is correct option.

38. According to old convention, the colour of neutral wire is:

(a) black (b) green
(c) red (d) none of these

Ans : SQP 2009

According to the international old colour convention, the colour of neutral wire is black.
Thus (a) is correct option.

39. An electric device gives out 5760 J of heat energy in 1 min, when current flows through it at a potential difference of 24 V. Find the resistance of the device

(a) 6 Ω (b) 3 Ω
(c) 5 Ω (d) 2 Ω

Ans : COMP 2015

Heat Energy given out,
$$E = 5760 \text{ J}$$
$$t = 1 \text{ min.} = 60 \text{ s}$$
Potential difference = 24 Volt
Resistance $R = \frac{V^2 t}{E}$
$$= \frac{24 \times 24 \times 60}{5760} = 6\Omega$$

Thus (a) is correct option.

40. In a household electric circuit all appliances are connected in :

(a) mixed circuit (b) parallel circuit
(c) series circuit (d) any of these

Ans : SQP 2022

All appliances in a household electric circuit are connected in parallel to each other.
Thus (b) is correct option.

41. An electric kettle rated 250 V can bring a certain amount of water to its boiling point in 8 min. If it is connected to 200 V mains, calculate the time in which water comes to its boiling point.

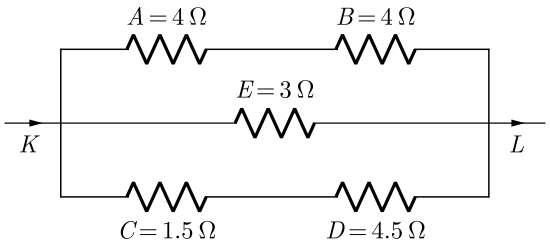
(a) 2.15 min (b) 12.5 min
(c) 5.45 min (d) 3.45 min

Ans : COMP 2018

Energy consumed by water in 8 min at 250 V
$$E = \frac{V^2 t}{R}$$
$$= \frac{250 \times 250 \times 8\,\text{min}}{R} \quad ...(1)$$

Energy consumed by water at 200 V
$$E = \frac{V^2 t}{R}$$

NODIA



Resistances A and B are in series

$$R_1 = 4 + 8 = 12\Omega$$

Resistance C and D are in series

$$R_2 = 1.5 + 4.5 = 6\Omega$$

Now R_1, E and R_2 are in parallel

Equivalent resistance between K and L

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{E} + \frac{1}{R_2}$$

$$\frac{1}{R} = \frac{1}{12} + \frac{1}{3} + \frac{1}{6}$$

$$= \frac{1+4+2}{12} = \frac{7}{12}$$

$$R = \frac{12}{7} = 1.71\Omega$$

Thus (d) is correct option.

52. Two conductors A and B have 500 and 100 units of negative charge when the conductors are connected by an electric wire the conventional current flows from :

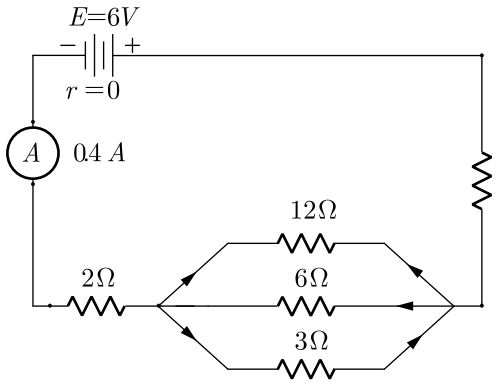
(a) B to A
(b) A to B
(c) Current does not flow
(d) None of these

Ans : MAIN 2008

The direction of the current is the direction in which the positive charge moves.

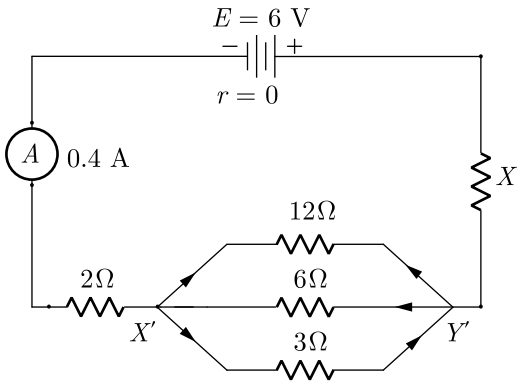
Thus (a) is correct option.

53. Carefully study the circuit diagram in figure and calculate the value of resistor x.



(a) 11.28 Ω (b) 1.3 Ω
(c) 28 Ω (d) 30 Ω

Ans : COMP 2017



Effective resistance between $X'Y'$ is given by

$$\frac{1}{R_1} = \frac{1}{12} + \frac{1}{6} + \frac{1}{3}$$

$$= \frac{1+2+4}{12} = \frac{7}{12}$$

$$R_1 = \frac{12}{7}\Omega$$

$$V = 6\text{Volt}$$

$$I = 0.4 \text{ A}$$

Total resistance in circuit

$$R = \frac{V}{I} = \frac{6}{0.4}$$

$$R = \frac{60}{4} = 15\Omega$$

$$2\Omega + \frac{12}{7}\Omega + X = 15$$

$$X = 15 - 2 - \frac{12}{7}$$

$$= \frac{91-12}{7} = \frac{79}{7}$$

$$= 11.28$$

$$X = 11.28\Omega$$

Thus (a) is correct option.

54. An electric device consumes 8640 J of energy in 30 min. while operating at 24 V. Calculate the current drawn by the device.

(a) 0.5 A (b) 0.3 A
(c) 0.4 A (d) 0.2 A

Ans : SQP 2005

As we know that,

$$VIt = W$$

$$24 \times I \times (30 \times 60) = 8640$$

Click Here to Buy book on Amazon

$$= \frac{220 \times 220 \times 15 \text{ min}}{R} \quad ...(i)$$

Energy consumed by water in 18.15 min at 220 V

$$E = \frac{V^2 t}{R}$$

$$= \frac{V^2 \times 18.15 \text{ min}}{R} \quad ....(ii)$$

By law of conservation of energy

$$\frac{V^2 \times 18.15}{R} = \frac{220 \times 220 \times 15}{R}$$

$$V^2 = (220)^2 \times \frac{1500}{1815} = 40000$$

$$V^2 = (200)^2$$

$$V = 200 \text{ Volt.}$$

Thus (d) is correct option.

47. A conductor of length 85 cm has a resistance of 3.750. Calculate the resistance of a similar conductor of length 540 cm.

(a) 23.82 Ω (b) 33.82 Ω
(c) 3.82 Ω (d) 13.82 Ω

Ans : COMP 2018

Given, $l_1 = 85$ cm $R_1 = 3.75\Omega$

$l_2 = 540$ cm $R_2 = ?$

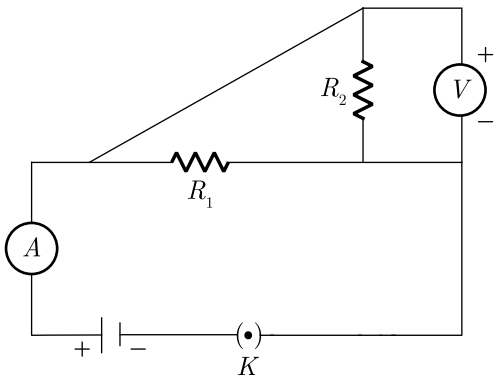
Now, $\frac{R_2}{R_1} = \frac{l_2}{l_1}$

$$R_2 = \frac{l_2 R_1}{l_1} = \frac{540 \times 3.75}{85}$$

$$R_2 = 23.82\Omega$$

Thus (a) is correct option.

48. For the given circuit, name the components which are connected in parallel.



(a) R_1, R_2 and V (b) Both R_1 and R_2
(c) Both R_2 and V (d) Both R_1 and V

Ans : SQP 2009

For the given circuit diagram, the components R_1 , R_2 and V are connected in parallel combination.

Because terminals of the resistance and voltmeter are connected together.

Thus (a) is correct option.

49. Which is not the property of a solenoid ? The magnetic field of solenoid can be increased

(a) by increasing the number of turns in the solenoid.
(b) by placing a laminated soft iron core within the solenoid.
(c) by increasing the strength of current flowing through the solenoid.
(d) by placing a stainless steel core within the solenoid.

Ans :. SQP 2011

The magnetic field of solenoid can be increased by placing a stainless steel core within the solenoid.

Thus (d) is correct option.

50. An electric heater draws a current of 3.5 A at a potential difference of 250 V. Calculate the power of four such heaters.

(a) 1500 W (b) 3500 W
(c) 2500 W (d) 4500 W

Ans : MAIN 2019

Given, Current, $I = 3.5$ A

Potential difference $V = 250$ Volt

Power, $P = VI$

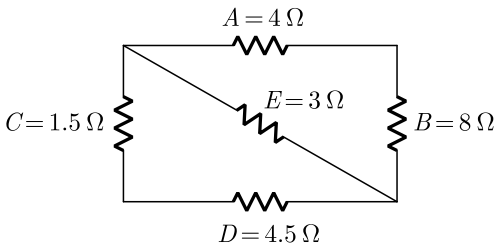
Hence, Power of 4 heaters $P = 4VI$

$$P = 4 \times 250 \times \frac{35}{10}$$

$$= 3500 \text{ W}$$

Thus (b) is correct option.

51. Calculate the equivalent resistance of circuit diagram shown in figure below.



(a) 2.71 Ω (b) 3.71 Ω
(c) 0.71 Ω (d) 1.71 Ω

Ans : COMP 2017

The figure given in the question can be redraw as follows :

Downloaded from www.pdf.tube

$$= \frac{200 \times 200 \times t}{R} \quad ...(2)$$

By law of conservation of energy

$$\frac{200 \times 200 \times t}{R} = \frac{250 \times 250 \times 8}{R}$$

$$t = \frac{250 \times 250 \times 8}{200 \times 200}$$

$$= 12.5 \text{ min.}$$

Thus (b) is correct option.

42. Which is not the use of an electromagnet ?
(a) Used for magnetising steel bars.
(b) Used for making sensitive magnetic compass
(c) Used in electric appliances such as electric bell and electric fans.
(d) Used in separating iron particles from a scrap of iron and other metals.

Ans : MAIN 2010

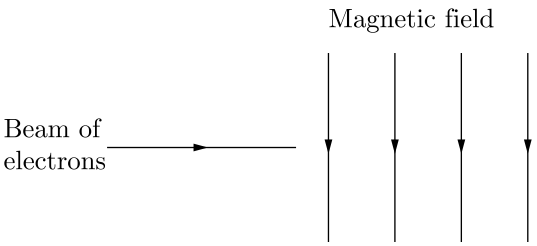
Electromagnet is not used for making sensitive magnetic compass. The magnetic needle used in the compass is made up of permanent magnet.
Thus (b) is correct option.

43. An average lighting circuit of a poor family has a fuse rating of
(a) 5 A (b) 15 A
(c) 10 A (d) 2 A

Ans : SQP 2020

The rating of a fuse connected in the general household lighting circuit is 5A.
Thus (a) is correct option.

44. The diagram shows a beam of electrons entering a magnetic field.

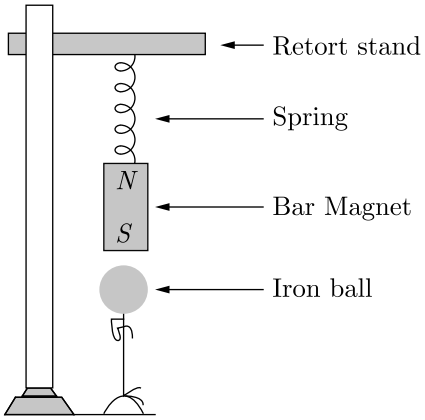


(a) they are deflected into the plane of the diagram.
(b) they are deflected towards the top of the diagram.
(c) they are deflected out of the plane of the diagram.
(d) they are deflected towards the bottom of the diagram.

Ans : MAIN 2016

As the beam of electrons are entering a magnetic field, horizontally and perpendicular to magnetic field, according to right hand thumb rule, electrons are deflected towards the top of the diagram.
Thus (b) is correct option.

45. Ravi designed the toy shown below using a bar magnet, a spring and an iron ball.



Which of the following correctly shows how the forces are interacting to keep the ball floating ?
(a) Magnetic force is equal to gravitational force
(b) The sum of elastic spring force and gravitational force is equal to frictional force
(c) Elastic spring force is equal to magnetic force
(d) The sum of elastic spring force and magnetic force is equal to gravitational force

Ans : COMP 2004

The spring is being pulled downwards by the magnet, hence elastic spring force is acting upwards. The magnetic force is acting upwards to attract the ball to the magnet. But gravitational force is pulling the ball downwards. Since, the ball is kept floating, the sum of elastic spring force and magnetic force must be equal to gravitational force.
Thus (d) is correct option.

46. An immersion heating rod is rated 220 V and can bring certain amount of water to its boiling point in 15 min. When this immersion rod is actually connected to an electric circuit, it brings the water to boil in 18.15 min. Calculate the line voltage.
(a) 805 V (b) 300 V
(c) 560 V (d) 200 V

Ans : MAIN 2023

Energy consumed by water in 15 min at 220 V

$$E = \frac{V^2 t}{R}$$

NODIA

$$I = \frac{8640}{24 \times 30 \times 60} = 0.2 \text{ A}$$

Thus (d) is correct option.

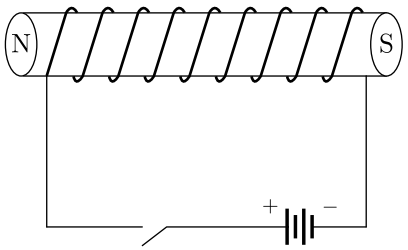
55. By reversing the direction of current in an electromagnet, the magnetic field produced by it
(a) remains unchanged in strength and direction.
(b) gets reversed in direction.
(c) increases in strength.
(d) decreases in strength.

Ans : SQP 2009

On reversing the direction of current in a wire, the polarity of the faces of the wire also reverses. Thus, the direction of magnetic field produced by it also gets reversed
Thus (b) is correct option.

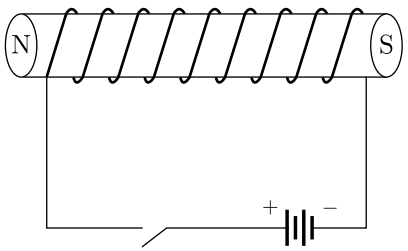
56. A permanent magnet can be demagnetised by using a solenoid and switching the current on then off.
Which diagram shows the most effective method of producing demagnetisation ?

(a)



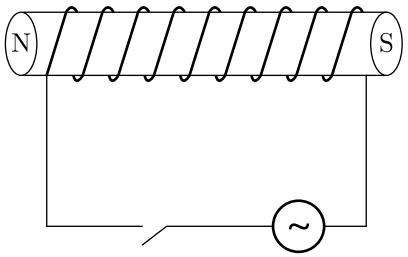
Magnet left in Place

(b)



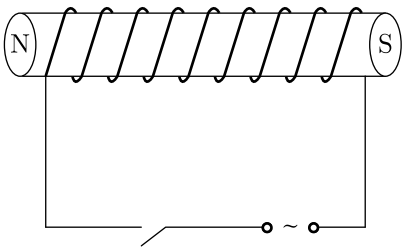
Magnet withdrawn before switching off

(c)



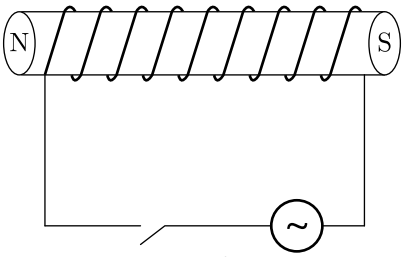
Magnet left in Place

(d)



Magnet withdrawn before switching off

Ans : SQP 2022



Magnet left in Place

AC current in Figure (c) and (d) are applied AC current is applied to demagnetise a magnet and DC current is applied to magnetise a magnetic material.
If magnet is withdrawn before switching off the DC power supply, then dipoles will remain aligned and magnetisation will be retained by the magnet.
Thus (c) is correct option.

57. Calculate the resistance of nichrome wire, which will bring 200 g of water at 20°C to its boiling points in 7 minutes, when current flowing through wire is 4 A.
(a) 10 Ω (b) 3 Ω
(c) 5 Ω (d) 2 Ω

Ans : MAIN 2008

Given, $I = 4\text{A}, R = ?, t = 7 \text{ min} = 420 \text{ s}$
Energy required to heat water

$$E = Q = mc(T - t)$$
$$E = mc(T - t)$$
$$= I^2 Rt$$
$$200 \times 4.2 \times (100 - 20) = 4 \times 4 \times R \times 420$$

Hence, $$R = 200 \times \frac{42}{10} \times 80 \times \frac{1}{420 \times 16}$$
$$= 10\Omega$$

Thus (a) is correct option.

Click Here to Buy book on Amazon

Ans : SQP 2008

Given, $V = 200\text{Volt}$

$t = (5 \times 60)\ \text{s}$

Heat energy $Q = W = mcT$

$m = 500\ \text{g}$

$C = 0.6\ \text{Jg}^{-1}\,^{\circ}\text{C}^{-1}$

$VIt = mcT$

Rise in temp. $T = (60 - 10) = 50^{\circ}\text{C}$

$$200 \times I \times 300 = 500 \times \frac{6}{10} \times 50$$

$$I = \frac{500 \times 30}{300 \times 200}$$

$$= \frac{1}{4} = 0.25\ \text{A}$$

Thus (d) is correct option.

82. A conductor at 4.2 K is found to offer no resistance. Such a conductor is called

(a) zero conductor (b) absolute conductor
(c) superconductor (d) none of these

Ans : COMP 2012

A conductor at 4.2 K is found to offer no resistance. Such a conductor is called superconductor
Thus (c) is correct option.

83. An electric kettle draws a current of 4 A for 2.5 min. If the resistance of its element is 100 Ω, calculate the electric energy drawn by kettle in kilojoules.

(a) 100 kJ (b) 240 kJ
(c) 200 kJ (d) 140 kJ

Ans : SQP 2018

Given, Current $I = 4\ \text{A}$,

Time $t = (2.5 \times 60)$ sec.,

Resistance $R = 100\Omega$

Electric energy drawn $W = I^2Rt$

$$W = 4 \times 4 \times 100 \times \left(\frac{25}{10} \times 60\right)$$

$$= 240000\ \text{J}$$

$$W = \frac{240000}{1000} = 240\ \text{kJ}$$

Thus (b) is correct option.

84. According to new convention, the colour of live wire is :

(a) light blue (b) brown
(c) green (d) yellow

Ans : COMP 2003

Thus (b) is correct option.

85. A wire of length 40 cm and area of cross-section 0.1 mm^2 has a resistance of 0.8 Ω.The specific resistance of the wire is

(a) $0.00003\,\Omega\text{-cm}$ (b) $0.00004\,\Omega\text{-cm}$
(c) $0.00001\,\Omega\text{-cm}$ (d) $0.00002\,\Omega\text{-cm}$

Ans : MAIN 2016

$l = 40\ \text{cm},$

Area of cross-section $a = 0.1\ \text{mm}^2 = \frac{0.1}{100}\ \text{cm}^2$

$R = 0.8\Omega$

Specific resistance of wire

$$\rho = \frac{Ra}{l} = \frac{0.8}{40} \times \frac{1}{1000}$$

$$\rho = 0.00002\,\Omega\text{-cm}$$

Thus (d) is correct option.

86. Resistance of a conductor of length 75 cm is 3.25 Ω. Calculate the length of a similar conductor, whose resistance is 13.25 Ω.

(a) 105.76 cm (b) 305.76 cm
(c) 205.76 cm (d) 405.76 cm

Ans : SQP 2001

$l_2 = ?\ R_2 = 13.25\,\Omega$

$l_1 = 75\ \text{cm}\ R_1 = 3.25\,\Omega$

As we know that,

$$R = \frac{\rho l}{A}$$

$$\frac{l_2}{l_1} = \frac{R_2}{R_1}$$

$$l_2 = \frac{R_2 l_1}{R_1}$$

$$= \frac{13.25 \times 75}{3.25}$$

Hence, $l_2 = 305.76\ \text{cm}$

Thus (b) is correct option.

ASSERTION AND REASON

87. **Assertion :** A resistor of resistance R is connected to an ideal battery. If the value of R is decreased, the power dissipated in the circuit will increase.
Reason : The power dissipated in the circuit will increase.

NODIA

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!

63. Which of the following is non-ohmic resistance ?
(a) Copper wire
(b) Constantan wire
(c) Brass wire
(d) Copper wire wound on an electromagnet

Ans : COMP 2000

Brass wire is non-ohmic resistance.
Thus (c) is correct option.

64. A resistance wire made from German silver has a resistance of 4.25 Ω. Calculate the resistance of another wire, made from same material, such that its length increases by 4 times and area of cross-section decreases by three times.
(a) 41.00 Ω (b) 51.00 Ω
(c) 21.00 Ω (d) 31.00 Ω

Ans : SQP 2009

Given, $R_1 = 4.25,\ l_1 = l$

$a_1 = a$

$R_2 = ?,\ l_2 = 4l$

$a_2 = \frac{a}{3}$

As both the wires are made of the same material have same specific resistance

$$\rho = \frac{R_1 a_1}{l_1} = \frac{R_2 a_2}{l_2}$$

$$R_2 = \frac{R_1 a}{l} \times \frac{4l}{\frac{a}{3}}$$

Hence, $R_2 = 12$

$$R_1 = 12 \times 4.25 = 51.00\Omega$$

Thus (b) is correct option.

65. Two unequal resistances are connected in parallel by a student. Which of the following is true ?
(a) Current is same in both
(b) Voltage drop is lower in lower resistance
(c) Current is larger in higher resistance
(d) Voltage drop is same across both

Ans : COMP 2011

If two unequal resistances are connected in parallel by a student, then voltage drop is same across both because in parallel combination,

$$\frac{V}{R_{eq}} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Potential difference across each resistor is same.
Thus (d) is correct option.

66. An electric bulb is rated 500 W − 200 V. Calculate the magnitude of current.
(a) 2.5 A (b) 3.8 A
(c) 2.0 A (d) 8 A

Ans : MAIN 2002

$$P = 500 \text{ W},\ V = 200 \text{ Volt}$$

As we know that,

$$\text{Current, } I = \frac{P}{V} = \frac{500}{200} = 2.5$$

$$I = 2.5 \text{ A}$$

Thus (a) is correct option.

67. Calculate the heat energy given out by the filament of an electric bulb in 20 s, when its resistance is 4 Ω and potential difference across its ends in 12 V.
(a) 120 J (b) 380 J
(c) 800 J (d) 720 J

Ans : SQP 2005

Given, $t = 20$ s, $R = 40$,

Potential difference $V = 12$ Volt

Heat energy given out by filament

$$E = \frac{V^2 t}{R}$$

$$E = \frac{12 \times 12 \times 20}{4} = 720 \text{ J}$$

Thus (d) is correct option.

68. Commutator is a device in a D.C. motor which :
(a) reverses direction of current after half rotation of coil.
(b) increases the strength of electromagnet.
(c) increases the power.
(d) reverses direction of current coil after full rotation of coil.

Ans : MAIN 2011

The function of the commutator is to change the direction of the current after every half rotation. Therefore, a commutator is a device in a d.c. motor which reverses the direction of current after half rotation of the coil.
Thus (a) is correct option.

69. In which of the following cases emf is not induced?
(a) A magnet is moved through a loop of wire.
(b) A loop of wire is held near a magnet.
(c) A current is started in a wire held near a loop of wire.
(d) The current is switched off in a wire held near a loop of wire.

Ans : SQP 2019

Downloaded from www.pdf.tube

58. Kilowatt hour is commercial unit of :
(a) heat energy (b) mechanical energy
(c) power (d) electric energy

Ans : MAIN 2020

Commercial unit of electrical energy is kWh (kilowatt-hour). It is defined as energy consumed by an appliance of 1kW when it is used for one hour.
Thus (d) is correct option.

59. An electric oven of resistance 20 Ω draws a current of 10 A. It works 3 hours daily. Calculate the weekly bill when energy costs 1.50 per kWh.
(a) 63 (b) 78
(c) 45 (d) 112

Ans : COMP 2000

Given $R = 20\Omega,\ I = 10\text{ A},\ t = 3$ hrs daily

As we know that, $P = VI$

Also, $V = IR$

$P = (IR)\,I$

$P = I^2R$

$P = 10 \times 10 \times 20$

$= \frac{2000\,W}{1000} = 2$ kW

Total consumption of elective over per day

$= 2 \times 3 = 6$ kWh

Electric oven works 3 hours daily
Energy consumed per day = 6 kWh

Cost per kWh = Rs. 1.50

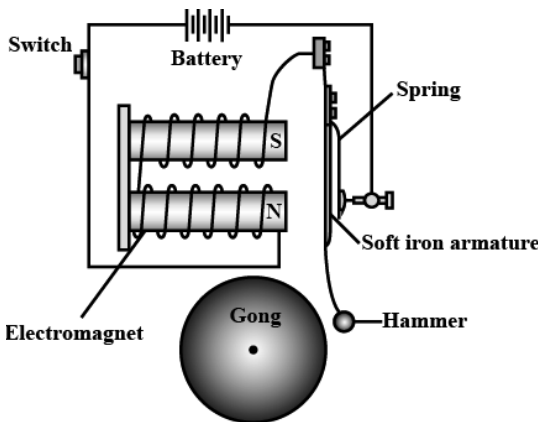
Hence, Energy consumed in one week

$= 6 \times 7 = 42$ kWh

Weekly bill $= 42 \times 1.5 = 63$

Thus (a) is correct option.

60. The diagram shows an electric bell.



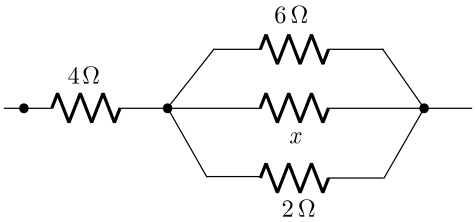
Which materials would be suitable for the parts labelled P, Q and R ?

	P	Q	R
(a)	Soft iron	Brass	Soft iron
(b)	Soft iron	Brass	Brass
(c)	Soft iron	Soft iron	Spring steel
(d)	Spring steel	Soft iron	Spring steel

Ans : COMP 2017

P, Q must not retain induced magnetism and they must be of soft iron. R must return the striker back to its original position when P and Q lose their magnetism.
Thus (c) is correct option.

61. Equivalent resistance of circuit diagram is 5 Ω. Calculate the value of x



(a) 9 Ω (b) 7 Ω
(c) 3 Ω (d) 10 Ω

Ans : SQP 2013

Equivalent resistance of the circuit $= 5\Omega$

$$5 = 4 + \left(\frac{1}{2} + \frac{1}{6} + \frac{1}{x}\right)$$

$$1 = \frac{1}{2} + \frac{1}{6} + \frac{1}{x}$$

$$\frac{1}{x} = \frac{1}{1} - \frac{1}{2} - \frac{1}{6}$$

$$= \frac{6-3-1}{6} = \frac{1}{3}$$

$$x = 3\Omega$$

Thus (c) is correct option.

62. In a series circuit :
(a) current flowing through all resistors is same
(b) The combined resistance of all resistors is less than individual resistors
(c) potential difference across all resistors is same
(d) none of the above

Ans : MAIN 2008

In series combination, the current is same through all resistors as there is just one path for the current to flow.
Thus (a) is correct option.

NODIA

Ans : COMP 2004

The direction of induced current may be found easily by applying either Fleming's Right-hand Rule. Fleming's Right-hand Rule (for generators) shows the direction of induced current when a conductor attached to a circuit moves in a magnetic field.
Thus (a) is correct option.

76. A switch in a circuit is always connected in the :
(a) neutral wire (b) earth wire
(c) live wire (d) either (a) or (b)

Ans : MAIN 2003

The current flows through the live wire to the appliance. So a switch in a circuit is always connected in the live wire.
Thus (c) is correct option.

77. Calculate the energy released by a heater, which draws a current of 5A at 220 V for 1 min.
(a) 66 J (b) 660 J
(c) 66000 J (d) 6600 J

Ans : SQP 2002

$$\text{Energy released } W = VIt$$
$$W = 220 \times 5 \times 60$$
$$= 66000 \text{ J}$$

Thus (c) is correct option.

78. An electric bulb draws a current of 0.8 A and works on 250 V on an average 8 hrs a day. If energy costs 1.50 per board of trade unit, calculate the monthly bill.
(a) 78 (b) 72
(c) 83 (d) 112

Ans : MAIN 2000

Given, $I = 0.8$ A ; $V = 250$ Volt

$$\text{Power} = VI$$
$$= 250 \times \frac{8}{10} = 200 \text{ W}$$

Energy consumed per day
$$= 200 \times 8 = 1600 \text{ Wh}$$
$$= \frac{1600}{1000} = 1.6 \text{ kWh}$$

Energy consumed in 30 days
$$= 1.6 \times 30 = 48 \text{ kWh}$$

$$\text{Cost per kWh} = 1.5$$

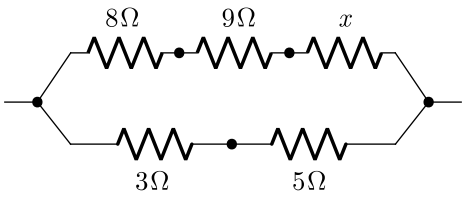
Hence, $\text{Monthly bill} = 48 \times 1.5 = 72$ Rs
Thus (b) is correct option.

79. A fuse wire is connected in ..... before the switch.
(a) neutral wire (b) live wire
(c) earth wire (d) either (a) or (c)

Ans : COMP 2011

A fuse wire is connected in live wire before the switch.
Thus (b) is correct option.

80. Equivalent resistance of circuit diagram is 6 Ω. Calculate the value of x.



(a) 8 Ω (b) 7 Ω
(c) 9 Ω (d) 10 Ω

Ans : MAIN 2022

8 Ω, 9 Ω, x Ω are in series

$$R_1 = 8 + 9 + x$$
$$= (17 + x)\,\Omega \quad \text{...(i)}$$

3 Ω and 5 Ω are in series

$$R_2 = 3 + 5 = 8\Omega \quad \text{...(ii)}$$

Now Equivalent resistance of R_1 and R_2 which are in parallel is $R_3 = 6\Omega$

$$\frac{1}{R_3} = \frac{1}{R_1} + \frac{1}{R_2}$$
$$\frac{1}{6} = \frac{1}{(17+x)} + \frac{1}{8}$$
$$\frac{1}{17+x} = \frac{1}{6} - \frac{1}{8}$$
$$= \frac{1}{24}$$
$$17 + x = 24$$
$$x = 24 - 17 = 7$$
$$x = 7\Omega$$

Thus (b) is correct option.

81. Calculate the current flowing through an electric drill, connected to 200 V supply, if it drills a hole in a metal plate of mass 500 g, such that its temperature rises from 10°C to 60°C in 5 minutes, assuming all the work done is converted into heat energy.
[S.H.C. of metal 0.6 $\text{Jg}^{-1}\,^{\circ}\text{C}^{-1}$]
(a) 0.80 A (b) 0.38 A
(c) 0.65 A (d) 0.25 A

Click Here to Buy book on Amazon

112. A substance has nearly zero resistance at a temperature of 1 K. What is such a substance called?

Ans : SQP 2010

Super conductor.

113. Give two characteristic properties of copper wire which make it unsuitable for use as fuse wire.

Ans : COMP 2009

Copper cannot be used as fuse wire because :
(a) it has high melting point.
(b) low resistivity.

114. Name the material which is used as a fuse wire.

Ans : COMP 2009

Alloy of lead and tin, which has high resistivity and low melting point.

115. Write one advantage of connecting electrical appliances in parallel combination.

Ans : MAIN 2019

All appliances will continue to work even if one of the appliance does not work.

116. What characteristics should a fuse wire have?

Ans : SQP 2019

High resistivity and low melting point.

117. Which wire in a power circuit is connected to the metallic body of the appliance?

Ans : COMP 2019

The ground wire.

118. Colour code of the wire which is connected to the metallic body of an appliance.

Ans : COMP 2017

Green and Yellow strips.

119. Explain the meaning of the statement 'current rating of a fuse is 5 A.

Ans : SQP 2017

It means that it can withstand a maximum current of 5 A before it "blows".

120. In the transmission of power the voltage of power generated at the generating stations is stepped up from 11 kV to 132 kV before it is transmitted. Why ?

Ans : MAIN 2017

Due to this the current flowing in the circuit decreases. As a result heat losses I^2R decreases.

121. Name the device used to increase the voltage at a generating station.

Ans : SQP 2015

Transformer

122. At what frequency is A.C. supplied to residential houses?

Ans : COMP 2015

50 Hz

123. Name the wire in a household electrical circuit to which the switch is connected.

Ans : COMP 2015

Live wire.

124. Which particles are responsible for current in conductors?

Ans : COMP 2016

In conductors, electrons are responsible for current.

125. To which wire of a cable in a power circuit should the metal case of a geyser be connected?

Ans : MAIN 2016

In a power circuit, metal case of a geyser be connected to the earth wire.

126. To which wire should the fuse be connected?

Ans : MAIN 2016

Fuse should be connected to the live wire.

127. Name the transformer used in the power transmitting station of a power plant.

Ans : SQP 2016

In the power transmitting station of a power plant step-up transformer is used.

128. What type of current is transmitted from the power station ?

Ans : COMP 2016

Alternating current is transmitted from the power station.

129. Name the device used to increase the voltage at a generating station.

Ans : MAIN 2015

NODIA

(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

Ans :

Here, $P = \frac{E^2}{R}$,

so $P \propto R$ only when I is constant.
Here I increases as R is decreased. Hence the reason is wrong.
Thus (c) is correct option.

88. **Assertion :** The connecting wires are made of copper.
Reason : The electrical conductivity of copper is high.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

Ans :

Copper conducts the current without offering much resistance due to high electrical conductivity.
Thus (a) is correct option.

89. **Assertion :** When the length of a wire is doubled, then its resistance also gets doubled.
Reason : The resistance of a wire is directly proportional to its length.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

Ans :

The resistance of wire,

$$R = \rho\frac{1}{A}$$

i.e. $R \propto l$

Since, the resistance of a wire is directly proportional to its length, i.e. when the length of a wire is doubled/halved then its resistance also gets doubled/halved.
Thus (a) is correct option.

90. **Assertion :** The 200 W bulbs glow with more brightness than 100 W bulbs.
Reason : A 100 W bulb has more resistance than 200 W bulb.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

Ans :

The resistance, $R = \frac{V^2}{P}$

$$R \propto \frac{1}{P}$$

i.e. Higher the wattage of a bulb, lesser is the resistance and so it will glow bright.
Thus (a) is correct option.

91. **Assertion :** Heater wire must have high resistance will be melting point.
Reason : If resistance is high, the electric conductivity will be less.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

Ans :

Heater wire must have high resistance and high melting point, because in series current remains same, therefore according to Joule's law, $H = I^2Rt$, heat produced is high if R is high melting point must be high, so that wire may not melt with increase in temperature.
Thus (a) is correct option.

92. **Assertion :** When a battery is short-circuited, the terminal voltage is zero.
Reason : In the situation of a short-circuit, the current is zero

NODIA

(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

Ans :

In the case of a short-circuited battery, the current

$$I = \frac{E(\text{e.m.f. of the battery})}{r(\text{internal resistance})} \neq 0$$

Terminal voltage, $V = IR$

$= I(i) = I(0) = 0$

Where, $R =$ external resistance $= 0$

Thus (c) is correct option.

93. **Assertion :** If ρ_1 and ρ_2 be the resistivity of the materials of two resistors of resistances R_1 and R_2 respectively and $R_1 > R_2$.

Reason : The resistance $R = \rho\frac{l}{A} \Rightarrow \rho_1 > \rho_2$ if $R_1 > R_2$.

(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

Ans :

ρ is the characteristic of the material of resistors. It does not depend on the length and cross-sectional area of resistors. But R depends on the length and the cross-sectional are of the resistor. So, R_1 may be greater than R_2 even when $\rho_1 \leq \rho_2$
Thus (c) is correct option.

94. **Assertion :** Long distance power transmission is done at high voltage.

Reason : At high voltage supply power losses are less.

(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

Ans :

$$\text{Power loss} = i^2R = \left(\frac{P}{V}\right)^2 R$$

[$P =$ Transmitted power]

Thus (b) is correct option.

95. **Assertion :** Resistance of 50 W bulb is greater than that of 100 W.

Reason : Resistance of bulb is inversely proportional to rated power.

(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

Ans :

$$P = \frac{V^2}{R}$$

$$R \propto \frac{1}{P} \text{ (Same rated voltage)}$$

Thus (b) is correct option.

ONE MARK QUESTIONS

DIRECTION : Complete the following by choosing the correct answers from the bracket:

96. Two copper wires can have the different ..... [*resistivity / resistance*] but will have same ..... [*resistance / resistivity*]

Ans : SQP 2025

resistance, resistivity

97. For a fuse, higher the current rating ..... is the fuse wire.

Ans : SQP 2015

For a fuse, higher the current rating thicker is the fuse wire.

98. Define specific resistance and state its SI unit.

Ans : COMP 2017

It is the resistance of unit cube of the material. Its SI unit is ohm-meter.

Downloaded from www.pdf.tube

99. State the characteristics required in a material to be used as an effective fuse wire.

Ans : SQP 2016

The material should have high resistivity and low melting point.

100. What is consumed using different electrical appliances, for which electricity bills are paid?

Ans : SQP 2014

Electrical energy.

101. An electric heater has a rating 220 V - 1000 W. What does it mean?

Ans : SQP 2012

220 V - 1000 W means that if the electric heater is supplied 220 V, it consumes 1000 W electric power (i.e. 1000 J of electric energy converts into heat and light energy) in 1 s.

102. What is the purpose of a fuse in an electrical circuit?

Ans : COMP 2010

The electric fuse is a device to limit the current in an electric circuit so that the appliances connected in the circuit may be safeguarded from being damaged.

103. Write an expression connecting the resistance and resistivity of a wire. Explain the symbols used.

Ans : COMP 2008

The required expression is $R = \rho\frac{l}{A}$, where R is the resistance of wire, ρ is the resistivity of the material of the wire, l is the length of wire and A is the area of cross-section of the wire.

104. Which arrangement of electrical devices in series or parallel do we prefer in household circuit and why ?

Ans : COMP 2005

We prefer the connections in parallel, because even if one of the devices gets fused, the others go on working, moreover, all the devices work on same voltage.

105. What is an Ohmic resistor?

Ans : COMP 2014

The resistors which obey Ohm's law are called ohmic resistors or linear resistances.

106. Explain briefly how a magnet can be demagnetised using an alternating current.

Ans : SQP 2004

We wind an insulated copper wire around the magnet and pass alternating current through it. This alternating current will change the polarities of the magnet rapidly. This will ultimately result in the loss of magnetic property of the magnet.

107. Mention two factors on which the internal resistance of a cell depends.

Ans : COMP 2004

The internal resistance of a cell depends upon :
(i) the nature of the electrolyte used,
(ii) the area of the two electrodes and the distance of separation between them.

108. Two sets A and B of four bulbs each, are glowing in two separate rooms. When one of the bulbs in set A is fused, the other three bulbs also cease to glow. But in set B when one bulb fuses the remaining ones continue to glow. Explain the difference.

Ans : SQP 2002

In set A, the bulbs are joined in series, so there is only one path of current for each bulb. But in set B, the bulbs are joined in parallel, so there is separate path of current for each bulb.

109. State Faraday's first law of electromagnetic induction.

Ans : SQP 2000

Whenever magnetic field through a coil is changed, an emf is produced in the coil. The emf lasts as long as the magnetic field through the coil changes.

110. What happens to the resistivity of semi-conductors with the increase of temperature?

Ans : MAIN 2015

Resistivity of semi-conductors decreases with the increase of temperature.

111. State any two factors which affect the resistance of a metallic wire.

Ans : SQP 2010

The resistance of a metallic wire is affected by :
(a) its area of cross-section
(b) its temperature.

NODIA

As the loop of the wire is held near the magnet but the loop and the magnets are not moving, hence no emf will be induced.
Thus (b) is correct option.

70. In an electric motor :
(a) electric energy changes to mechanical energy.
(b) mechanical energy changes to heat energy.
(c) mechanical energy changes to electric energy.
(d) electric energy changes to magnetic energy

Ans : COMP 2021

An electric motor converts electrical energy into rotational kinetic energy which is a form of mechanical energy.
Thus (a) is correct option.

71. A current I flows through a resistance R for the time 't', the electric energy consumed by the resistance is:
(a) $I \times R \times t$ (b) $I \times R^2 \times t$
(c) $\frac{I^2 \times R}{t}$ (d) $I^2 \times R \times t$

Ans : MAIN 2020

Thus (d) is correct option.

72. Two resistors of 2 Ω each are connected in a parallel. The equivalent resistance is :
(a) less than 2 Ω but more than 1 Ω
(b) between 4 Ω and 2 Ω
(c) one ohm
(d) four ohm

Ans : SQP 2007

The equivalent resistance in parallel combination is given by

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$
$$= \frac{1}{2} + \frac{1}{2} \Rightarrow R = 1\Omega$$

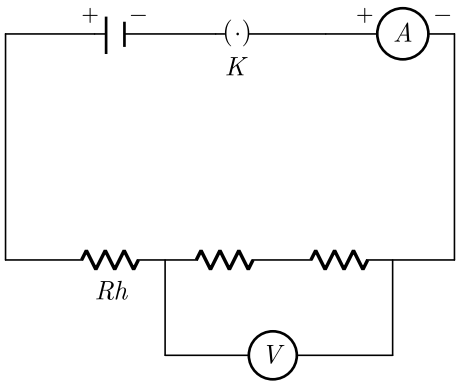
Thus (c) is correct option.

73. Amongst the following substance, the resistance will decrease with the increase in temperature in case of :
(a) copper (b) nichrome
(c) brass (d) carbon

Ans : COMP 2012

For carbon, resistance decreases with increase in temperature, due to negative temperature coefficient .
Thus (d) is correct option.

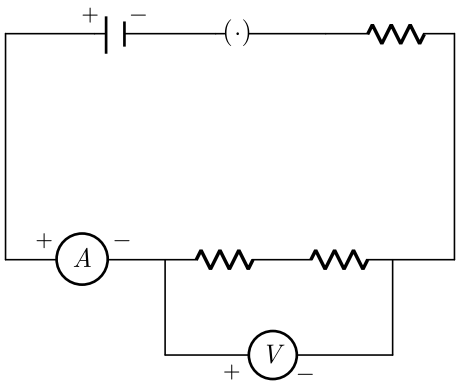
74. To determine the equivalent resistance of two resistors when connected in series, a student arranged the circuit components as shown in the diagram. But he did not succeed to achieve the objective.



Which of the following mistakes has been committed by him in setting up the circuit?
(a) Position of ammeter is incorrect
(b) Terminals of ammeter are wrongly connected
(c) Position of voltmeter is incorrect
(d) Terminals of voltmeter are wrongly connected

Ans : MAIN 2009

According to the diagram, student has connected the apparatus, but terminals of the ammeter is wrongly connected because ammeter is in series. Hence, positive terminal of ammeters should be connected with positive terminal of cell. Diagram is given below,



Thus (b) is correct option.

75. The direction of current in a conductor can be obtained by?
(a) Fleming right hand rule
(b) Maxwell's cork-screw rule
(c) Fleming left hand rule
(d) Right hand thumb rule

Click Here to Buy book on Amazon

At a generating station to increase the voltage, step up transformer is used.

130. At what voltage is this current available to our household ?

Ans : COMP 2016

220 V.

131. At what frequency is A.C. supplied to residential houses?

Ans : MAIN 2015

AC is supplied to residential houses at a frequency of 50 Hz.

132. Name the wire in a household electrical circuit to which the switch is connected.

Ans : SQP 2015

In a household electrical circuit, switch is connected to live wire

133. Name two safety devices which are connected to the live wire of a household electric circuit.

Ans : SQP 2018

Fuse, MCB

134. What is the colour code for the insulation on the earth wire?

Ans : MAIN 2011

Colour code for the insulation on the earth wire should be green or yellow.

135. Write an expression for calculating electrical power in terms of current and resistance.

Ans : MAIN 2011

Electrical power $P = I^2R$

136. Which particles are responsible for current in conductors?

Ans : COMP 2016

Electrons

137. To which wire of cable in a power circuit should the metal case of a geyser be connected?

Ans : SQP 2016

Earth wire

138. To which wire should the fuse be connected?

Ans : SQP 2016

Live wire

139. What is a permanent magnet ? Give one use of it

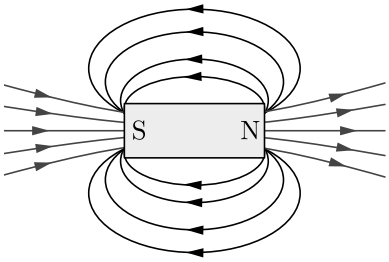
Ans : COMP 2011

A permanent magnet is a magnet made from steel such that once magnetised it does not lose its magnetism easily.
Use : It is used in galvanometer.

NODIA

140. Show with the help of a diagram that a current carrying solenoid is similar to a bar magnet.

Ans : MAIN 2013



141. Which particles are responsible for the flow of current in conductors (metals) and in liquids (electrolyte) ?

Ans : COMP 2000

Electrons.

142. Name one device which works on the magnetic effect of current.

Ans : SQP 2003

Electric motor.

143. What is the effect of temperature on metals and semiconductors?

Ans : COMP 2003

In case of metals resistance increases with the rise in temperature while in case of semiconductors, it decreases with the rise in temperature.

144. Name the factors on which force acting on a current carrying conductor depends.

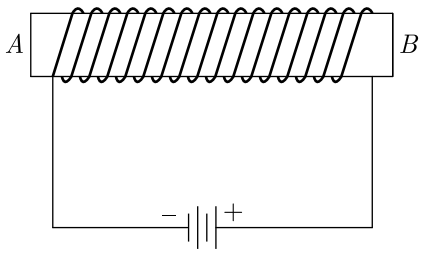
Ans : COMP 2015

The force depends upon
(i) the current through the conductor
(ii) the strength of the magnetic field and
(iii) the length of the conductor.

145. The filament of electric bulb is made of tungsten. Why ?

Ans : MAIN 2017

(i) What is the polarity at end A?
(ii) Give one advantage of an electromagnet over a permanent magnet.



Ans : COMP 2013

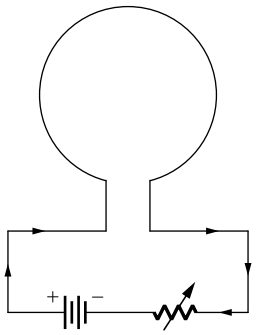
(i) Polarity at end A will be north pole.
(ii) Advantage of an electromagnet over a permanent magnet:
- Polarity can be reversed.
- Strength can be changed.
- Can be demagnetized.

238. (i) Name the device used to protect the electric circuits from overloading and short-circuits.
(ii) On what effect of electricity does the above device work?

Ans : SQP 2013

(i) Fuse is used to protect the electric circuits from overloading and short-circuits.
(ii) Fuse works on the heating effect of current

239. The diagram shows a loop of wire carrying current I.

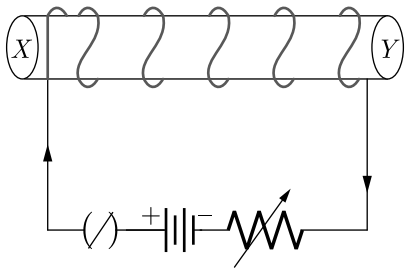


(i) What is the magnetic polarity of the loop which faces us ?
(ii) With respect to the diagram how can we increase the strength of the magnetic field produced by this loop ?

Ans : COMP 2011

(i) South pole.
(ii) By decreasing the resistance of the circuit. This will increase the current and hence the magnetic field of the loop.

240. The figure below shows an electromagnet :



(i) What will be the polarity at the end X ?
(ii) Suggest a way by which the strength of the electromagnet referred to in the question, may be increased.

Ans : MAIN 2017

(i) At end X-North polarity will be formed.
(ii) The strength of the electromagnet formed can be increased by (a) increasing the number of turns of the winding (b) increasing the current through it.

241. Current carrying conductor is placed in a magnetic field, it experiences a mechanical force. What should be the angle between the magnetic field and the length of the conductor so that the force experienced is :
(i) Zero
(ii) Maximum ?

Ans : MAIN 2017

The expression for force is $F = BIL \sin \theta$
(i) Zero force will be for $\theta = 0^0$.
(ii) Maximum force will be for $\theta = 90°$

242. (i) If a piece of soft iron is placed inside the current carrying coil, what is the name given to the device?
(ii) Give one use of the device named by you in (i) above.

Ans : SQP 2009

(i) Electromagnet
(ii) Electromagnet is used in electric bell.

243. Differentiate between A.C. and D.C. along with the graph.

Ans : MAIN 2009

The electric current which changes its direction (or polarity) after certain fixed interval of time is called A.C. or alternating current. Thus, in A.C., the polarity (+ or -) is not fixed and its current v/s time graph will be shown in figure. The

Downloaded from www.pdf.tube

157. What is meant by a resistance ?

Ans : SQP 2001

It is the opposition offered to the flow of current by a conductor.

158. Why is soft iron used as a core of the electromagnet in the electric bell?

Ans : COMP 2011

In an electric bell, soft iron is used as core of the electromagnet because as the current is passed through the electromagnet it becomes magnetised and as the circuit is broken, it immediately gets demagnetised.

159. Name the material which is used for making wires for heating coils. Give a reason.

Ans : COMP 2019

Nichrome is used for making wires to prepare heating coils. The reason is that its melting point and resistivity are high.

160. When is the potential difference between two points said to be 1 volt?

Ans : COMP 2021

The potential difference between two points is said to be one volt, if a work of 1 joule is done to move 1 coulomb of charge between two points.

161. State Ohm's law.

Ans : MAIN 2021

Physical conditions remaining same, the electric current flowing through a conductor is directly proportional to the potential difference across the two ends of the conductor.

162. What is the shape of magnetic field lines around a straight current carrying conductor?

Ans : SQP 2003

Concentric circles.

163. What is a solenoid ?

Ans : COMP 2003

A cylindrical coil of many tightly wound turns of insulated wires with generally diameter of the coil smaller than its length is called a solenoid.

164. Which has a greater resistance a 100 W bulb or a 60 W bulb?

Ans : MAIN 2007

A 60 W bulb has a greater resistance.

(V remains same) $P \propto \frac{1}{R}$, $P = \frac{V^2}{R}$

165. How can we maintain a potential difference across a conductor?

Ans : SQP 2007

By using a source of emf. For example - a battery.

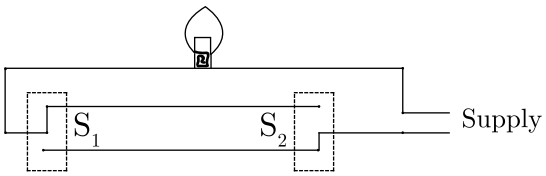
166. Define electrostatic potential at a point.

Ans : COMP 2021

Electric potential at a point is defined as the amount of work done in moving a unit positive charge from infinity to that point.

167. Draw a labelled diagram of the staircase wiring for a dual control switch showing a bulb in the circuit.

Ans : SQP 2019



168. Name the device which is used to reverse the direction of current in the coil of a motor after every half rotation.

Ans : SQP 2019

Commutator.

169. Is electrostatic potential a scalar quantity or a vector quantity?

Ans : SQP 2019

It is a scalar quantity.

170. What is the cause of resistance?

Ans : COMP 2011

During their motion through a conductor the electrons suffer collisions due to other electrons or the ions of the conductor. As a result, their motion is opposed. This opposition is the cause of resistance.

171. Define one watt.

Ans : COMP 2017

The power expended by a source is said to be 1 watt, if one ampere of current flows through it under a potential difference of 1 volt.

NODIA

A fuse is a safety device used to limit the current in an electric circuit when there is overheating or overloading in the circuit.

202. What are the characteristic properties of fuse wire?

Ans : SQP 2008

The characteristic properties of a fuse wire are
(1) low melting point and
(2) high resistance

203. Write an expression for the electrical energy spent in the flow of current through an electrical appliance in terms of I, R and t.

Ans : MAIN 2008

Electrical energy spent in the flow of current through an electrical appliance,

$$E = I^2Rt$$

204. At what voltage is the alternating current supplied to our houses ?

Ans : SQP 2005

Alternating current supplied to our houses is at 220 V.

205. How should the electric lamps in a building be connected ?

Ans : COMP 2005

In a building, electric lamps are connected in parallel combination.

206. What is the name given to a cylindrical coil whose diameter is less in comparison to its length?

Ans : SQP 2002

Solenoid.

207. A given wire is stretched to double its length. How will its resistivity change?

Ans : MAIN 2012

The resistivity of a conductor does not depend upon its shape or size. Therefore, there will be no change in the resistivity of the wire.

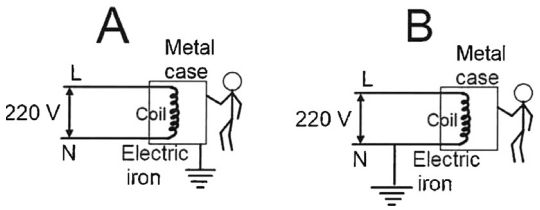
TWO MARKS QUESTIONS

208. (a) Name the principle of AC generator.
(b) State its one use.

Ans : SQP 2025

(a) Faraday's first law or principle of electromagnetic induction.
(b) It is used as a back-up for the lifts in tall buildings in case of electricity failure. (any use)

209. If live wire makes an accidental contact with the metal case, which circuit (A or B) in the diagram, illustrating an electric iron, is considered safe for the user (Assuming the fuse is present in the live wire in both circuits)? Justify your answer.



Ans : SQP 2025

Circuit in A.
In circuit A, metal case is earthed so the person won't get an electric shock but in circuit B metal case is not earthed so the circuit will be completed through the body of the person giving him a shock.

210. A transformer is used to change a high alternating e.m.f. to a low alternating e.m.f. of the same frequency.
(a) Identify the type of transformer used for the above purpose.
(b) State whether the turns ratio of the above transformer is $= 1$ or > 1 or < 1.

Ans : SQP 2025

(a) Step down transformer
(b) less than

211. A fuse is rated 5 A. Can it be used with a geyser rated 1540 W, 220 V. Write Yes or No. Give supporting calculations to justify your answer.

Ans : MAIN 2024

The geyser draws $I = \frac{P}{V} = \frac{1540}{220} = 7\text{A}$

Hence, 5 A rated fuse will blow off for the geyser.

212. 5 bulbs are connected in series in a room. One bulb is fused. It is removed and remaining 4 bulbs are again connected in series to the same circuit. What will be the effect on the following physical quantities? (Increases, Decreases, Remain Same)

Click Here to Buy book on Amazon

187. Give a single word for $\frac{1 \text{ joule}}{1 \text{ coulomb}}$.

Ans : COMP 2009

1 volt.

188. What happens to the resistivity of a conductor if its length is doubled?

Ans : COMP 2017

There is no change in the resistivity of the conductor, because it depends upon the nature of the conductor and not on its dimensions.

189. What is the function of carbon brushes?

Ans : SQP 2017

Carbon brushes make contact with the commutator to supply current to the armature in D.C. motor or pass the generated current to the load in D.C. generator.

190. A D.C. motor is rotating in anticlockwise direction. How can the direction of rotation be reversed?

Ans : SQP 2020

By reversing the connections of the terminals of the battery, the direction of rotation will be reversed.

191. Write Joule's law of heating.

Ans : COMP 2020

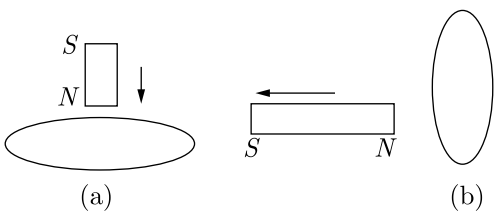
$$H = I^2Rt$$

192. State Faraday's second law of electromagnetic induction.

Ans : MAIN 2012

The induced emf depends directly upon the relative speed between the coil and the magnet.

193. Give the direction of induced current in the following figures :



Ans : COMP 2012

(a) Anticlockwise; as seen from top.
(b) Clockwise; as seen from side of the magnet.

194. Which part of an electrical appliance is earthed?

Ans : SQP 2003

Metallic body of the appliance is earthed.

195. State a relation between electrical power, resistance and potential difference in an electrical circuit.

Ans : MAIN 2003

Electrical power, $P = \frac{V^2}{R}$

196. What is the chief advantage of alternating current over direct current for the purpose of supplying power ?

Ans : COMP 2001

The voltage of alternating current can be changed with the help of transformers while that of direct current cannot be changed.

197. Why is it necessary to raise the emf to a high value when electricity is transmitted over a long distance ?

Ans : COMP 2001

For a given electrical power, the current becomes low at a high voltage. Therefore, the loss of energy in the transmission wires due to heating ($H = I^2Rt$) is reduced.

198. Why does a magnetic needle show a deflection when brought close to a current carrying conductor?

Ans : SQP 2010

The magnetic field of the current carrying conductor exerts a force on the magnetic needle.

199. A wire bent into a circle carries current in an anticlockwise direction. What polarity does this face of the coil exhibit?

Ans : SQP 2010

North pole.

200. A cell is sending current in an external circuit How does the terminal voltage compare with the e.m.f. of the cell ?

Ans : COMP 2016

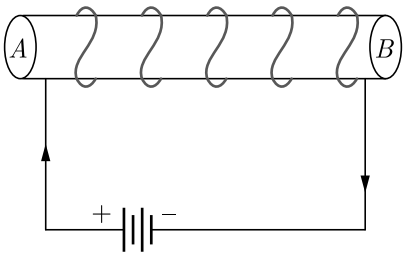
Terminal voltage will be less than e.m.f. of the cell.

201. What is the purpose of using a fuse in an electrical circuit ?

Ans : MAIN 2019

Downloaded from www.pdf.tube

222. You have been provided with a solenoid AB.



(i) What is the polarity at end A ?
(ii) Give one advantage of an electromagnet over a permanent magnet.

Ans : COMP 2013

(i) North
(ii) Strength of an electromagnet can be changed according to its use and it will be a magnet till the time current passes through it whereas strength of permanent magnet cannot be increased and cannot be magnetised and demagnetised in an instance.

223. (i) Name the device used to protect the electric circuits from overloading and short circuits.
(ii) On what effect of electricity does the above device work ?

Ans : SQP 2013

(i) Fuse.
(ii) Heating effect of electric current.

224. (a) An electrical gadget can give an electric shock to its user under certain circumstances. Mention any two of these circumstances.
(b) What preventive measure provided in a gadget can protect a person from an electric shock?

Ans : COMP 2013

(a) An electrical gadget can give an electric shock to its user if:
  (i) The live wire comes in contact with the user's body.
  (ii) The body of the appliance is not properly earthed.
(b) Earthing of the appliance protects the person from an electric shock.

225. (i) Name two safety devices which are connected to the live wire of a household electrical circuit.
(ii) Give one important function of each of these two devices.

Ans : COMP 2011

(i) Connected devices are switches and fuse to live wire.
(ii) **Fuse :** It is a safety device which is used to limit current in an electric circuit.
Switch : Its main function is either to connect or to disconnect an electric appliance in an electric circuit.

226. (a) What is an A.C. generator or dynamo used for?
(b) Name the principle on which it works.

Ans : MAIN 2012

(a) An A.C. generator or dynamo converts mechanical energy into electrical energy.
(b) An A.C. generator works on the principle of electromagnetic induction.

227. State two dissimilarities between a D.C. motor and an A.C. generator.

Ans : SQP 2010

Two dissimilarities between a D.C. motor and an A.C. generator are as follows :

	D.C. motor	**A.C. generator**
(i)	It is used to convert electrical energy (dc) into mechanical energy of rotation of the coil.	It is used to convert mechanical energy of rotation into electrical energy.
(ii)	It is based on the fact that when a coil carrying current is held in a magnetic field it experiences a torque which rotates the coil.	It is based on the phenomenon of electromagnetic induction.

NODIA

228. Device is used to transform 12 V A.C. to 200 V A.C.
(a) What is the name of this device ?
(b) Name the principle on which it works.

Ans : SQP 2010

(a) Step-up transformer.
(b) It works on the principle of electromagnetic induction.

229. Of the three connecting wires in a household circuit.
(i) Which two wires are at the some potential?
(ii) In which of the three wires should the switch be connected ?

(a) Resistance
(b) Intensity of light

Ans : MAIN 2024

(a) Resistance decreases
(b) Current (Intensity of light) increases as resistance decreases.

213. State two factors affecting the speed of rotation of the coil in a D.C. motor.

Ans : MAIN 2024

Speed of rotation may be increased by Increasing the number of turns of the armature. Increasing the applied battery e.m.f.

214. Two copper wires are of the same length, but one is thicker than the other.
(1) Which wire will have more resistance?
(2) Which wire will have more specific resistance?

Ans : MAIN 2014

(1) As resistance is inversely proportional to area of cross-section, the wire with less thickness has more resistance.
(2) Resistivity or specific resistance is $\rho = \frac{RA}{l}$.

So the thicker wire will have more specific resistance as resistivity is directly proportional to area of cross-section.

215. How does an increase in the temperature affect the specific resistance of a :
(i) Metal and
(ii) Semiconductor ?

Ans : SQP 2019

(i) Increases
(ii) Decreases

216. Identify the following wires used in a household circuit:
(i) The wire is also called as the phase wire.
(ii) The wire is connected to the top terminal of a three-pin socket.

Ans : COMP 2018

(i) Live wire
(ii) Earth wire.

217. (i) Why does a current carrying freely suspended solenoid rest along a particular direction?
(ii) State the direction in which it rests.

Ans : MAIN 2019

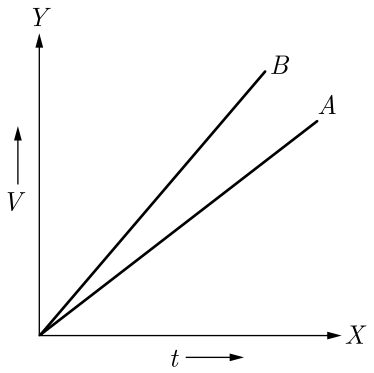
(i) A current carrying freely suspended solenoid behaves like a bar magnet.
(ii) It rests in geographic north-south direction.

218. Give two similarities in an A.C. generator and a D.C. motor.

Ans : MAIN 2015

(i) Both in an A.C. generator and a D.C. motor, a coil rotates in a magnetic field between the pole pieces of a powerful magnet.
(ii) In both carbon brushes are present.

219. The $V-I$ graph for a series combination and for a parallel combination of two resistors is shown in the figure below. Which of the two A or B , represents the parallel combination ? Give a reason for your answer.



Ans : COMP 2016

A represents for the parallel combination as the slope of A is less than B. Here, slope $\left(\frac{V}{I}\right)$ represents resistance of the combination of resistors and for parallel combination equivalent resistance is less than even the smallest resistance connected.

220. State the characteristics required in a material to be used as an effective fuse wire.

Ans : SQP 2016

The characteristics required in a material to be used as an effective fuse wire should be
(i) of high resistivity and
(ii) of low melting point so that it may easily melt due to overheating when excessive current passes through it.

221. Which coil of a step-up transformer is made thicker and why?

Ans : COMP 2016

In a step-up transformer, the wire used for primary coil is made thicker (low resistance) than the secondary coil so as to reduce the loss of energy due to heating in the coil.

Click Here to Buy book on Amazon

172. Define resistivity.

Ans : SQP 2017

Resistivity of a material is the resistance of a conductor of this material of unit length and unit cross-sectional area.

173. What is the function of earth wire?

Ans : MAIN 2017

Earth wire is a safety measure which connects the metal case of an electrical appliance to earth at zero potential and if by chance the live wire touches the metal case of an appliance, the electric current directly passes to the earth through the earth wire without harming the user.

174. What do you mean by the statement that : "a bulb is marked as 60 W – 220 V" ?

Ans : SQP 2006

It means that if the bulb is lighted on a 220 V supply it consumes 60 W electrical power or 60 J of electrical energy converts into heat and light energy in 1 second.

175. What is meant by electromagnetic induction?

Ans : COMP 2006

It is the phenomenon of producing electric current in a conductor by changing the magnetic field through the conductor

176. Convert 1 kWh into joule.

Ans : MAIN 2006

$$1 \text{ kWh} = 1000 \text{ W} \times 3600 \text{ s}$$
$$= 3.6 \times 10^6 \text{ J}$$

177. What is the commercial unit of electric energy?

Ans : SQP 2011

Kilowatt hour (kWh).

178. State the function of a split ring in a D.C. motor.

Ans : COMP 2011

Function of a split ring in a D.C. motor is to reverse the direction of current in the coil of a motor after every half rotation.

179. What are the factors on which resistivity of a material depends?

Ans : COMP 2009

It depends only upon the nature of the conductor.

180. Define 1 volt.

Ans : SQP 2003

The potential difference between two points is said to be 1 volt, if a work of 1 joule is done to move 1 coulomb of charge between those two points.

181. State one point of similarity and one point of difference between an a.c. generator and a d.c. motor.

Ans : SQP 2003

Similarity: Both have a coil placed in the magnetic field.
Difference: The ends of the coil of an a.c. generator are connected to slip rings while in a d.c. motor they are connected to a pair of split rings.

182. Name essential parts of an a.c. generator.

Ans : SQP 2001

(i) Armature
(ii) Field magnet
(iii) Slip rings
(iv) Carbon brushes.

NODIA

183. What is the unit of resistance ?

Ans : COMP 2005

It is measured in ohm.

184. What is the energy conversion when an electric current passes through a metallic wire ?

Ans : SQP 2007

When an electric current passes through a metallic wire, the wire becomes hot and the electric energy is converted into heat energy.

185. How is alternating current different from direct current?

Ans : MAIN 2007

Alternating current changes in magnitude and its direction reverses periodically whereas direct current direction remains same.

186. Why are thick copper wires used as connecting wires?

Ans : SQP 2009

The resistance of connecting wires should be almost negligible. For this, thick wires are used since a thicker wire has a small resistance and the wires are of copper because the resistivity of copper is low.

Ans : COMP 2007

(i) The neutral wire and the earth wire are at the some potential.

(ii) The switch wire should always be connected in live wire circuit.

230. In a three-pin plug, why is the earth pin made longer and thicker than the other two pins?

Ans : SQP 2005

(i) It is made thick to ensure that the body of the appliance has a very good contact with the earth. Thick wire has a low resistance so allows easy flow of current through it.

(ii) It is made longer so that its connection is made first.

231. Which of the two wires of similar dimension, copper or nichrome, would you use for the electric heater ? Give reasons to justify your answer.

Ans : MAIN 2003

We should choose the nichrome wire for making the electric heater element due to the following reason. The copper wire has a very small resistance. If an element made of this wire is used in an electric heater, it would draw a very large current from the mains. The resulting heat produced would be so large that the fuse would be blown off and the heater element itself would melt. The copper wire heater element would thus be neither long lasting nor safe to use. It is also because nichrome has a very high resistance as compared to copper.

232. Two fuse wires of the same length are rated 5 A and 20 A. Which of the two fuse wires is thicker and why?

Ans : COMP 2003

The fuse wire rated 20 A would be the thicker of the two. The thicker wire (for the same length and material) would have a lower resistance than the thin wire. It will, therefore, produce less heat for a given current. It can, therefore, carry a much larger current through it before melting down.

233. Explain briefly the function of the following in the household wiring (i) a three pin plug and (ii) main switch.

Ans : SQP 2002

(i) A three pin plug is used to supply electricity to any electrical appliance whose body is earthed. The third big pin of the plug helps us to do this earthing. The user of the electrical appliance is then protected against accidental electrical shocks.

(ii) The main switch is connected right at the starting point of the household wiring. This enables us to switch off (or 'on') the supply of electricity to the household, as per our need.

234. How does the power rating of a device help us to decide about the type of leads (connecting wires) to be used for that ?

Ans : COMP 2001

We know that $P = VI$ or $I = P/V$. Thus, the current flowing through a device is directly proportional to its power. Thus, knowledge of the power-voltage rating of a device helps us to know the current flowing through it. This, is turn, helps us to decide about the type of leads to be used for it. We use thick wires (or leads) if the current flowing is more than 5 A. For currents less than 5 A, we use relatively thinner wires (or leads).

235. Distinguish between terminal potential difference and emf of a cell.

Ans : MAIN 2004

Electromotive force : Emf, is the difference of potential between two terminals of the cell, when no current is being drawn from it. It is independent of the external resistance in the circuit. It is greater than the P.D. across any circuit.

Potential difference : It is the difference of potential between any two points in a closed circuit i.e., when current is being drawn by the circuit. Potential difference between two points is proportional to the resistance. It is always lesser than the emf.

236. Two copper wires are of the same length, but one is thicker than the other.

1. Which wire will have more resistance?
2. Which wire will have more specific resistance?

Ans : MAIN 2014

1. The thinner wire will have more resistance as the resistance is inversely proportional (to area of cross-section $\left(R \propto \frac{1}{A} \text{ or } R \propto \frac{1}{\pi r^2}\right)$
2. Both copper wires will have the same specific resistance as specific resistance depends on the nature of the material of the wire which is the same for both the wires.

237. You have been provided with a solenoid AB.

Downloaded from www.pdf.tube

Because it has a high melting point and a high resistivity and does not easily react with air.

146. Define current. Give its SI unit.

Ans : SQP 2009

Current is defined as the rate of flow of charge. It is measured in ampere (A).

147. What will happen if switch is connected in 'neutral wire'?

Ans : MAIN 2022

If switch is connected in the neutral wire, an electric appliance e.g., an electric iron will remain connected to the live wire even when the switch is off and so if anyone happens to touch the appliances; he or she will get a shock which is sometimes fatal.

148. What special characteristics must :
(a) A heating wire and
(b) Fuse wire have?

Ans : SQP 2022

A heating wire must have high resistivity and high melting point, while a fuse wire a high resistance and a low melting point.

149. What are the factors on which heat dissipated by a conductor depends?

Ans : COMP 2022

Heat dissipated depends upon
(i) the square of current through the conductor
(ii) the resistance of the conductor and
(iii) the time for which current is passed.
i.e., $Q = I^2Rt$

150. Why should the melting point of a fuse wire be low?

Ans : COMP 2013

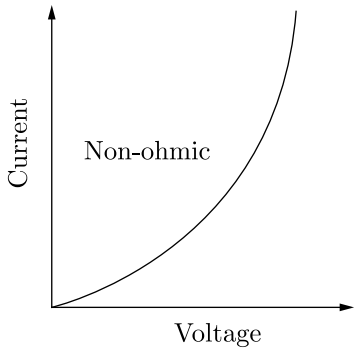
It melts and breaks the circuit as soon as the safe limit of current is exceeded.

151. What are non-ohmic conductors ? Give one example. Draw a current-voltage graph for such a conductor.

Ans : MAIN 2013

Conductors which do not obey Ohm's law (i.e., $V \propto I$) are called non-ohmic conductors. For example, Diode valve. The $V - I$ graph for such a conductor is as below :

NODIA



152. What is potential difference? Is it a scalar quantity or a vector quantity? Give its SI unit.

Ans : SQP 2007

It is the amount of work done in moving a unit charge between two given points. It is a scalar quantity and is measured in volt.

153. If current is flowing in a straight wire from south to north, what will be the direction of magnetic field lines?

Ans : COMP 2012

Anticlockwise.

154. Why is it not advisable to use a piece of copper wire as a fuse wire in an electric circuit?

Ans : MAIN 2009

Because copper has a high melting point. It will not melt easily when a high electric current passes through it and may damage the electrical appliances.

155. Name a few practical applications of heating effect of current.

Ans : SQP 2017

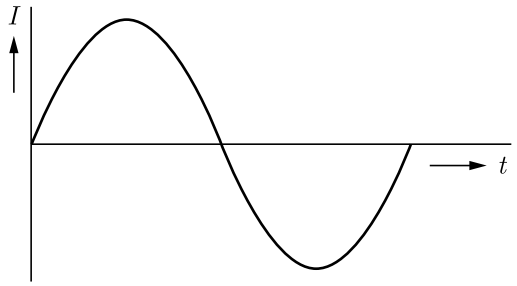
A few examples of the practical applications of heating effect are the various heating devices. Some of these are safety fuse, electric lamp, electric iron, electric oven, electric geyser, electric kettle etc.

156. What determines the direction of flow of electrons between two charged conductors kept in contact ?

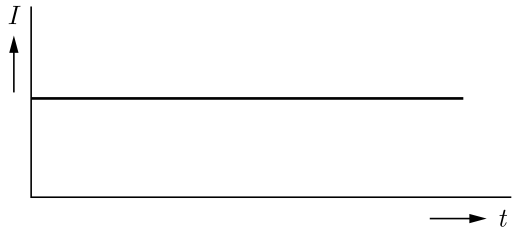
Ans : SQP 2013

The potentials of the two conductors determine the direction of flow of electrons. The electrons flow from a conductor at lower potential to a conductor at higher potential.

electric current which always flows in the same direction is called direct current or D.C. Thus, in D.C. the polarities (+ or –) are fixed.
The current obtained from the battery or a cell is D.C. The current v/s time graph of D.C. is as shown in figure.



Graphical representation of A.C.



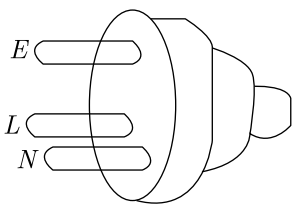
Graphical representation of D.C.

244. What purpose is served by the terminals of a three way in plug?

Ans : MAIN 2023

In this plug, the three pins L for live wire, N for neutral wire and E for earthing are marked on the case of the plug. The earth pin being thicker cannot enter in live or neutral sockets.

The earth pin being longer, gets connected to earth terminal first; thus ensuring that the user will not get an electric shock.



245. What is meant by MCB ? Which part of the domestic electric circuit does it replace?

Ans : SQP 2021

MCB stands for Miniature Circuit Breaker. This is a device that automatically 'switches off' the mains supply if the current drawn exceeds the upper safe limit. It protects the entire circuit and appliances against short circuiting etc.
The MCB replaces the 'main fuse'. It is more reliable, easy to operate and versatile than the latter.

246. How can an electric heater designed for 220 V be adopted for 110 V without changing the length of the coil and also without a change in the consumed power?

Ans : COMP 2021

Join the ends of the coil and apply the supply voltage (110 V) between this common terminal and the mid-point of the coil. Now, the coil consists of two parts both having a resistance of $R/2$ i.e., half the original resistance. Therefore, power consumed by each half now will be $P' = P/2$ i.e., half the original power consumed. Since these are connected in parallel, therefore, the total power consumed will be P.

247. Name the colours of the three core cable along with their corresponding electrical connections to a socket.

Ans : SQP 2000

As per the new internationally accepted convention brown is for live, light blue is for neutral and green and yellow striped for earth.

248. Explain briefly how a fuse protects an electric circuit.

Ans : COMP 2008

The fuse protects an electric circuit by melting and breaking the circuit, whenever the current exceeds the pre-determined limit in the circuit. Due to low melting point, the fuse wire melts and then breaks the circuit.

249. Which part of an electrical appliance is earthed?

Ans : MAIN 2010

The outer metallic part of the body of an electrical appliance, which can be handled physically, is earthed for the safety reasons. For earthing of an appliance, the earth wire of the cable is connected to the outer metallic case of the appliance.

250. What is the commercial unit of electrical energy? Convert it into joule. What is the other name of the commercial unit?

Ans : MAIN 2022

The commercial unit of electrical energy kilowatt hour (kWh).

Click Here to Buy book on Amazon

(b) $P = i^2 R$

where i is current passed through the conductor and R is the resistance of the conductor.

310. State the factors that alter the resistance of a conductor.

Ans : MAIN 2013

Factors upon which the resistance R of a conductor depends are

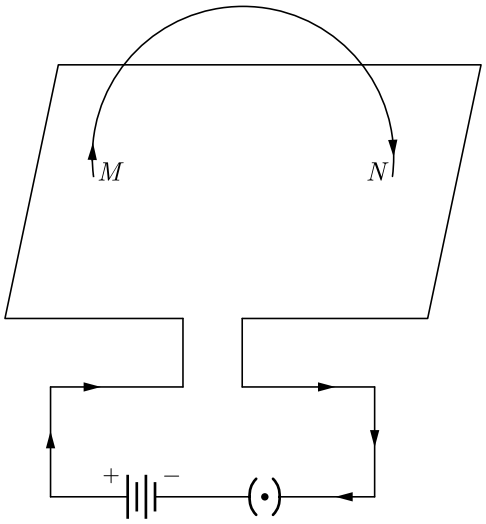
$R \propto l$, where l is the length of the wire.

$R \propto \frac{1}{A}$, where A is the area of cross-section of wire.

or $R \propto \frac{1}{A}$

or $R = \frac{\rho l}{A}$ where ρ is a constant, called specific resistance or resistivity of the conductor which depends upon the nature of the conductor and temperature.

311. The diagram below shows a current carrying loop or a circular coil passing through a sheet of cardboard at the points M and N. The sheet of cardboard is sprinkled uniformly with iron filings.

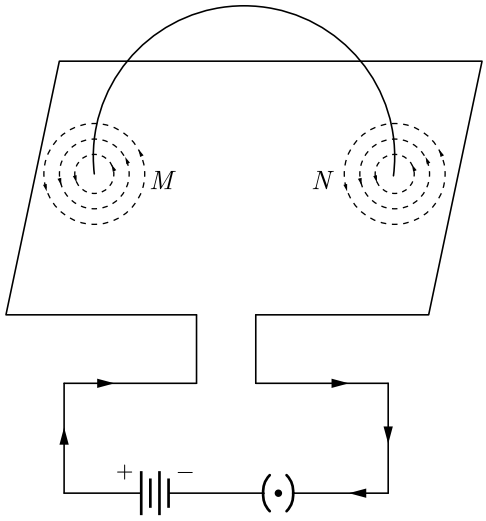


(i) Copy the diagram and draw an arrow on the circular coil to show the direction of current flowing through it.

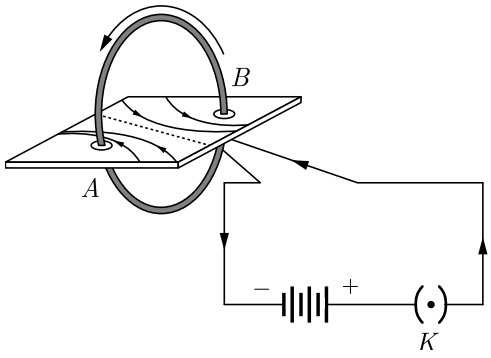
(ii) Draw the pattern of arrangement of the iron filings when current is passed through the loop.

Ans : MAIN 2015

(i)



(ii)



312. A large number of free electrons are present in metals. Why is there no current in the absence of electric potential across it ?

Ans : COMP 2018

The current is due to flow of charge in a definite direction. In metals, the free electrons move in all directions in a zig-zag manner. The number of electrons crossing any section of conductor in one direction is equal to the number of electrons crossing in opposite direction. Hence, there is no current in the metal. When potential difference is applied across the metal almost all the electrons start moving opposite to the direction of the potential, hence current begins to flow.

313. State the factors that alter the resistance of a conductor.

Ans : SQP 2016

Resistance $\propto$ length

$$R \propto \frac{1}{\text{area of cross} - \text{section}}$$

$R \propto \rho$ (specific resistance)

NODIA

live wire of the switch.

258. Bends in a rubber pipe reduce the flow of water through it. How would the bends in a wire affect its electric resistance ?

Ans : SQP 2023

Bends in the wire will not affect its resistance. This is because the electrons are extremely small in size as compared to the bends. So, the electrons can easily change their direction of motion.

259. The wires connected to a bulb do not glow whereas the filament of a bulb glows when current flows through it.

Ans : COMP 2012

The resistance of the wires connected to the bulb is low therefore, less heat is produced. Because heat produced is given by $H = I^2Rt$, where I is the current which is same in the wire and the bulb because they are connected in series.

260. How are Fleming's left hand rule and right hand rule different from each other?

Ans : SQP 2010

Fleming's left hand rule is used to determine the direction of force experienced by a current carrying conductor placed in the magnetic field while Fleming's right hand rule determines the direction of induced current in the closed loop/ coil when it is rotated in the magnetic field.

261. How can you determine the direction of magnetic field lines produced by a straight wire?

Ans : COMP 2017

According to Maxwell's right hand grip rule.
Imagine a wire carrying current to be held in your right hand with its thumb stretched along the direction of current, the direction in which fingers curl, gives the direction of magnetic field. This rule can be used other way also, i.e. if the curled fingers of the right hand represent the direction of the current, the thumb gives the direction of the magnetic field.

262. State two characteristics of a primary coil of a step-up transformer when compared to the secondary coil.

Ans : MAIN 2002

(i) In a step-up transformer, primary coil consists of thick insulated copper wire as high current flows in its turns, while the wire of the secondary is thin due to the flow of weak current at high voltage.

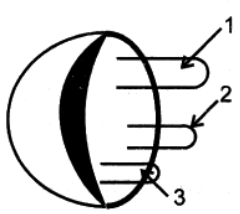
(ii) The number of turns in the primary coil is less as its e.m.f. is less while the number of turns in the secondary coil is more due to its high e.m.f. This is due to the fact that the e.m.f. (or voltage) induced in the turns of the secondary coil directly depends on the number of turns in it.

263. Why do we transmit alternating current at high voltage?

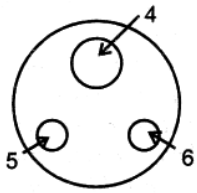
Ans : MAIN 2007

Electricity transmission is done at high voltage, i.e. at low current, the energy loss due to heating (i^2Rt) will be reduced considerably. Besides it, for low current thin wires can be used and for thin wires less support is required, which makes the transmission economical. Therefore, the electricity generated at the power house is stepped up to 11 kV to 400 kV or so for transmission to main sub-stations where it is stepped down to 33 kV or so. At this voltage it is transmitted to the city sub-stations where it is further stepped down to 220 V/440 V for supply to consumer as per their requirements (domestic/commercial).

264. The diagrams (a) and (b) given below are of a plug and a socket with arrows marked as 1, 2, 3 and 4, 5, 6 respectively on them. Identify and write Live (L), Neutral (N) and Earth (E) against the correct number.

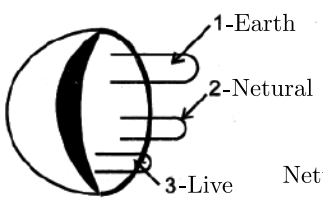


(a) Plug

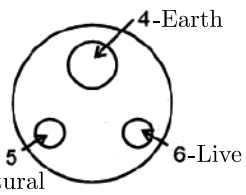


(b) Socket

Ans : COMP 2011



(a) Plug



(b) Socket

NODIA

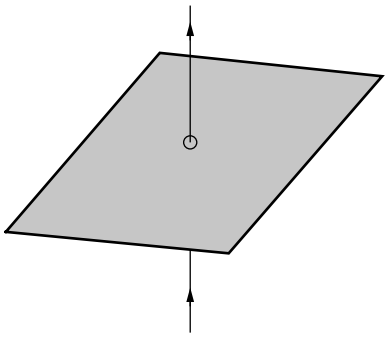
265. How does earthing prevent electrical shock?

Ans : COMP 2011

Earthing provides us safety from electric shock, e.g. in the case of short-circuiting when excessive current passes through the live wire, it will pass to the earth through the earth wire. In the absence of earthing, it may cause fire due to overheating of the live wire.

In case of an electric appliance, if its outer metallic body is earthed and by chance, if it comes in direct contact with the live wire, metallic casing acquires the potential of the live wire and so any person touching it is likely to get a fatal shock. But if earthed, a heavy current blows off the fuse connected to the appliance or passes to the earth and the person touching it does not get any shock.

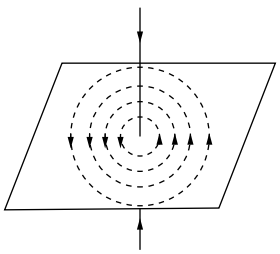
266. (i) A straight wire conductor passes vertically through a piece of cardboard sprinkled with iron fillings. Copy the diagram and show the setting of iron fillings when a current is passed through the wire in the upward direction and the cardboard is tapped gently. Draw arrows to represent the direction of the magnetic field lines.



(ii) Name the law which helped you to find the direction of the magnetic field lines.

Ans : SQP 2006

(i)



(ii) Right hand grip rule.

267. State two advantages of filling gas in an evacuated electric filament lamp.

Ans : SQP 2018

Advantages of filling gas in an evacuated electric filament lamp:

(i) Due to pressure of argon gas the rate of evaporation or disintegration of tungsten at low pressure and high temperature is reduced to almost negligible.

(ii) Efficiency is high and consumes only about 0.5 W/candle power.

268. (i) Which of the two wires of similar dimensions, of copper or nichrome, would you use for the electric heater element? Give reasons to justify your answer.

(ii) Two fuse wires of the same length are rated 5 A and 20 A. Which of the two fuse wires is thicker and why?

Ans : COMP 2013

(i) Nichrome, It is used to produce large amount of heat because of its high resistivity (or resistance) and high melting point.

(ii) Out of two fuse wires of same length rated 5 A and 20 A, wire carrying 20 A current should be thicker (i.e. of a larger area of cross-section). Because to carry large current conductance of the wire should be more or its resistance should be small.

269. Under what circumstances does one get an electric shock from an electric gadget?

Ans : SQP 2017

A person gets an electric shock from an electrical gadget under the following circumstances :

(i) When the outer body of an electric appliance, e.g. refrigerator, an electric geyser, an electric iron, etc. is not earthed and the live wire of a faulty appliance conies in direct contact with its metallic casing due to break of insulation, the whole appliance attains the potential of the live wire and so any person touching it will get a fatal shock.

(ii) By touching a switch with wet hands, one may get a shock. In such a case water forms a conducting layer between the hand and the live wire of the switch.

270. State two advantages of an electromagnet over a permanent magnet.

Ans : MAIN 2012

Downloaded from www.pdf.tube

Advantages of an electromagnet over a permanent magnet.

(i) The polarity of an electromagnet can be changed by reversing the direction of current in the solenoid while polarity of a permanent magnet is permanent.

(ii) The strength of the magnetic field of an electromagnet can be controlled by changing the magnitude of current but in permanent magnets, such change cannot be done.

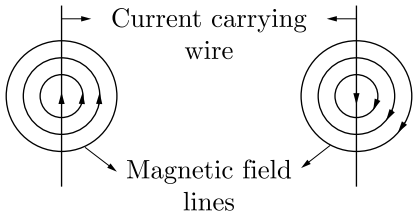
271. What is the function of split ring (or commutator) in a D.C. motor?

Ans : SQP 2006

The split ring in a D.C. motor acts as a commutator which changes the direction of the current through coil after every half rotation due to which coil continues to rotate in the same direction as the direction of the rotating couple remains unchanged.

272. Draw the magnetic field lines due to a straight wire carrying current.

Ans : MAIN 2011



Magnetic field lines due to a straight current carrying wire

273. How are the electromotive force in the primary and secondary coils of a transformer related with

(i) number of turns in both the coils and

(ii) the current induced in both the coils?

Ans : MAIN 2017

(i) $\frac{E_s}{E_p} = \frac{n_s}{n_p}$

(ii) $\frac{E_s}{E_p} = \frac{i_p}{i_s}$

where E—electromotive force, i—current induced in the coil, n—number of turns in the coil, subscripts p—primary coil and s—secondary coil.

274. Why is there a decrease in the resistance, when two resistors are connected in parallel ?

Ans : COMP 2019

When two resistors are connected in parallel, the effective area of cross-section through which the current can pass increases. Since the resistance of a wire is given by

$$R = \rho \frac{l}{A}$$

i.e., inversely proportional to the area of cross-section, therefore, any increase in area of cross-section decreases the resistance.

275. (a) State two ways by which the magnetic field of a solenoid can be made stronger.

(b) What material is used for making the armature of an electric bell?

Give a reason for using this material.

Ans : COMP 2013

(a) Magnetic field of a solenoid can be made stronger by increasing

(i) the current in the solenoid

(ii) the number of turns in the solenoid

(b) Soft iron is used for making the armature of an electric bell. Soft iron is magnetised easily on passing the current and completely demagnetised easily on withdrawing the current through the solenoid.

$$(R \propto T)$$

276. What is a fuse? How does it function?

Ans : SQP 2004

An electric fuse is a device which is used to limit the current in an electric circuit. The use of fuse is to safeguard the circuit and the appliances connected to it from being damaged. The fuse is a short piece of wire made of an alloy of lead and tin having a low melting point. When electric current is passed through it the fuse gets heated. If the current passing through the fuse exceeds the safeguard limit the heat produced melts the fuse and this breaks the circuit.

NODIA

277. Where is the fuse wire placed in an electrical circuit? Name a material suitable for making fuse wire.

Ans : COMP 2004

The fuse is placed in the live wire just after the 'electricity meter' of the consumer. Fuse wires are generally made of an alloy of tin and lead which has a relatively low melting point.

278. State two advantages of an electromagnet over a bar magnet.

293. What is earthing? What is its use?

Ans : COMP 2000

It is a process of connecting the metallic body of an appliance to the earth through a conductor. It protects the user of an appliance from electric shock.

294. Two electric lamps are connected in parallel. Which lamp's filament will carry more current?

Ans : COMP 2000

The current through the filament of a lamp is given by the expression

$$I = \frac{P}{V}$$

Since the lamps are connected in parallel, therefore, V is same for both. Hence, more current will flow through the filament of the lamp having more power.

295. Why is heat produced when a current is passed through a conductor?

Ans : SQP 2017

During their motion, the electrons collide with one another and hence lose some kinetic energy. This loss in kinetic energy is dissipated as heat across the conductor.

296. A given wire is stretched to double its length. How will its resistance change?

Ans : COMP 2020

When a given wire is stretched to double its length, its area of cross-section will be halved, so the resistance of wire will become four times.

297. What do you mean by the term magnetic effect of current? Who discovered this effect and how?

Ans : SQP 2020

The term magnetic effect of current means that a current carrying wire produces a magnetic field around it. Oersted in 1820 found that a wire carrying current deflects the magnetic compass needle placed around it. Hence, he gave magnetic effect of current.

298. State two ways of increasing the speed of rotation of a D.C. motor.

Ans : SQP 2014

Speed of rotation of a D.C. motor can be increased by:

(i) Increasing the current flowing in the coil.

(ii) Increasing the strength of radial magnetic field.

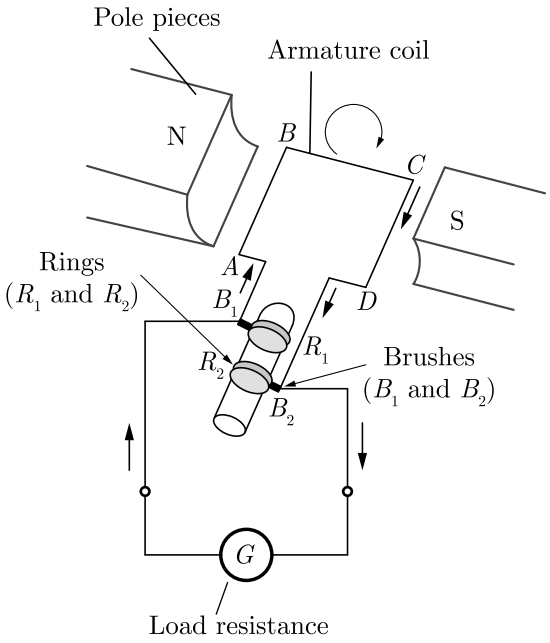
299. (a) State the energy change which takes place when a magnet is moved inside a coil having a galvanometer at its ends. Name this phenomenon.

(b) Draw a labelled diagram of an A.C. generator.

Ans : MAIN 2020

(a) Mechanical energy changes into electrical energy. Electromagnetic induction.

(b) The labelled diagram of A.C. generator is as shown:



300. Explain:

(i) Why are the pole pieces made cylindrical?

(ii) Why is a soft iron core used within the coil?

Ans : COMP 2022

(i) To keep the plane of the coil always in the direction of magnetic field lines, the pole pieces are made cylindrical.

(ii) Soft iron core, kept at the centre of the coil, intensifies the magnetic field and makes it radial by concentrating the field lines due to its high permeability.

301. You are provided a cell, an insulated copper coil, the soft iron bar and a switch. Draw a circuit diagram to represent the process of making an electromagnet.

Ans : MAIN 2023

Click Here to Buy book on Amazon

Ans : COMP 2011

(a) (i) Fuse and (ii) Switch

(b) Fuse is used to limit the current in a circuit and safeguard the appliances.
Switch is used for switching ON or switching OFF a circuit.

285. Obtain the expression for electric power consumed in a circuit.

Ans : SQP 2013

Power is defined as the rate of doing work

i.e. $$P = \frac{\text{Workdone}\,(W)}{\text{Time}\,(t)}$$

$$= \frac{V\,i\,t}{t} = V\,i \qquad ...(1)$$

By Ohm's law

$$V = i\,R$$

$$P = (i\,R)\,i$$

$$P = i^2 R \qquad ...(2)$$

$$P = \left(\frac{V}{R}\right)^2 R = \frac{V^2}{R} \qquad ...(3)$$

Thus, power consumed in an electrical circuit will be given by equations (1), (2) and (3).

286. What do you mean by fuse rating?

Ans : SQP 2013

Fuse rating means the current carrying capacity of the fuse wire depending upon the maximum current which a circuit or an appliance can withstand. It is usually 5 A for lighting circuits such that the fuse melts if the current in the circuit exceeds 5 A.

287. Of the three connecting wires in a household circuit:

(a) Which two of the three wires are at the same potential?

(b) In which of the three wires should the switch be connected?

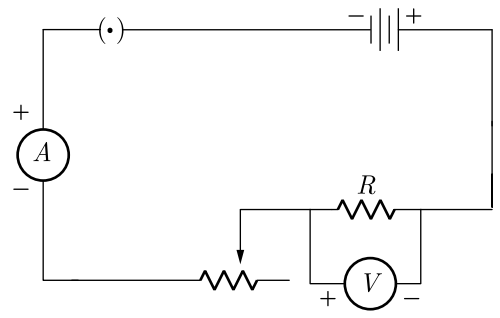
Ans : COMP 2003

(a) At the supply end, i.e. at the power station neutral wire and earth wire are connected together so that both of them are at zero potential.

(b) Switch should be connected in live wire.

288. Diagrammatically illustrate how you would connect a key, a battery, a voltmeter, an ammeter, an unknown resistance R and a rheostat so that it can be used to verify the above law.

Ans : MAIN 2021



NODIA

289. What is an electromagnet? What do you know about the simplest form of an electromagnet?

Ans : SQP 2022

The electromagnet is a temporary magnet which can be magnetised or demagnetised in a very short time as per our requirements. In its simplest form, an electromagnet consists simply of a soft iron core around which a large number of turns of insulated wire are wound.

290. What are the factors on which the strength of induced current depends?

Ans : COMP 2006

The strength of the induced current directly depends upon the following factors :

(i) Strength of the magnetic field.

(ii) Number of turns in the coil.

(iii) Relative speed between the coil and the magnet.

291. Give the factors on which, magnetic field produced by a current carrying solenoid depends.

Ans : COMP 2001

It depends upon (i) the current through the solenoid, (ii) the number of turns per unit length in the solenoid and (iii) nature of the core on which the solenoid is wound.

292. You have just paid the electricity bill for your house.

(i) What was it that your family consumed for which you had to pay?

(ii) In what unit was it measured?

Ans : SQP 2000

(i) We consumed electric energy for which we had to pay.

(ii) It was measured in Board of Trade (B.O.T.) unit or kWh.

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!

Ans : SQP 2007

Advantages of an electromagnet over a bar magnet:

(i) The polarity of an electromagnet can be changed by reversing the direction of current in the solenoid which cannot be done for a bar magnet.

(ii) The strength of the magnetic field of an electromagnet can be varied by changing the current or the number of turns in the solenoid which cannot be done for a bar magnet.

279. Bring out some points of distinction between A.C. and D.C.

Ans : MAIN 2019

Some of the points of distinction between A.C. and D.C. are as follows :

	Alternating Current (A.C.)	**Direct Current (D.C.)**
1.	Its magnitude as continuously changing.	Magnitude remains constant.
2.	Its direction reverses every half cycle.	Its direction always remains the same.
3.	It is more dangerous than D.C.	It is less dangerous compared with D.C.
4.	A transformer can be used to step-up or down the A.C.	A transformer cannot step-up or down the D.C.

280. What are the factors on which resistance of a conductor depends?

Ans : COMP 2010

The resistance of a conductor depends upon :

(i) The length of the conductor.

(ii) The area of cross-section of the conductor.

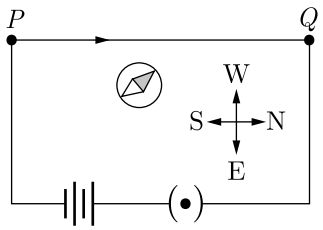
(iii) The nature of material of the conductor.

281. (a) What will happen to a compass needle when the compass is placed below a wire and a current is made to flow through the wire? Give a reason to justify your answer.

(b) What energy conversion takes place during the working of a D.C. motor?

Ans : MAIN 2023

(a) According to Oersted's experiment, on the magnetic effect of electric current, if a compass needle is placed below a wire carrying current as shown in the figure, let south to north direction, the needle will be deflected, i.e. the north end of the needle will be deflected towards the west.



(b) During the working of a D.C. motor electrical energy converts into mechanical energy.

282. What are high tension wires? Give two characteristics of these wires.

Ans : MAIN 2014

High tension wires are high voltage wires. Carrying heavy electric current at voltage ranging from 440 V to 132 kV or even more.

Characteristics:

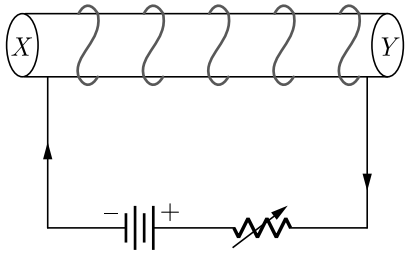
(i) These are properly insulated from the pole and quite thick.

(ii) These are kept well apart so that there is no short-circuiting.

283. The figure given below an electromagnet.

(a) What will be the polarity at the end X?

(b) Suggest a way by which the strength of the electromagnet referred to in the question, may be increased.



Ans : COMP 2011

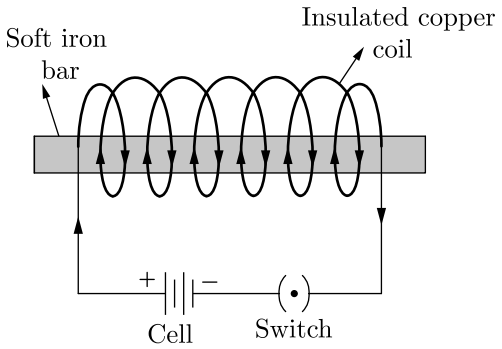
(a) The polarity at the end X : North pole.

(b) The strength of an electromagnet can be increased by increasing the strength of the current or by decreasing the resistance in the rheostat.

284. (a) Name two safety devices which are connected to the live wire of a household electrical circuit.

(b) Give one important function of each of these two devices.

Downloaded from www.pdf.tube



302. (a) Give two characteristic properties of copper wire which make it unsuitable for use as fuse wire.
(b) Name the material which is used as a fuse wire.

Ans : SQP 2016

(a) Copper wire is unsuitable for use as fuse wire because it has low resistance and high melting point.
(b) Fuse wire is an alloy of lead and tin.

303. The electrical gadgets used in a house such as bulbs, fans, heaters, etc. are always connected in parallel, not in series. Give two reasons for connecting them in parallel.

Ans : SQP 2016

(i) In parallel arrangement, each appliance works at the same voltage.
(ii) If one appliance stops working, the other appliances continue to work.

304. Why does a magnetic needle show a deflection when brought close to a current carrying conductor ?

Ans : COMP 2008

When an electric current is passed through a conducting wire, a magnetic field is produced around it. A compass needle, if freely suspended, rests in North-South direction but due to magnetic field produced around wire, the compass needle gets attracted or repelled and changes its direction.

305. Mention two reasons why a soft iron core is used within the coil of a moving coil galvanometer.

Ans : SQP 2009

(i) It concentrates the lines of magnetic field through the galvanometer coil.
(ii) It makes the field radial.

306. Why is soft iron generally used as the core of the electromagnet?

Ans : COMP 2003

(i) Soft iron has less retentivity so it acquires the magnetic properties only when the current flows through the coil wound on it and loses the magnetic properties as the current is switched off.
(ii) The soft iron intensifies the magnetic field of the electromagnet because of its high permeability.

307. What will be the effect on the working of an electric bell if instead of direct current, alternating current is supplied?

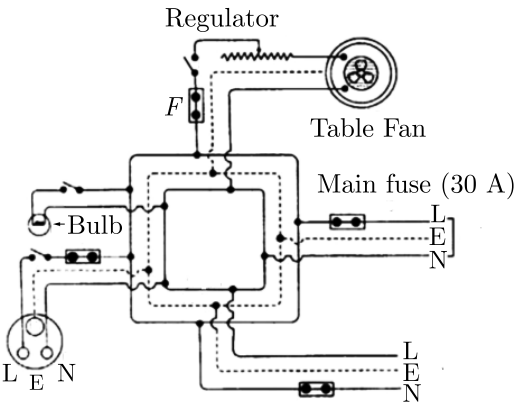
Ans : COMP 2003

Due to A.C., the polarity of electromagnet will keep on changing 50 times per second (because the frequency of alternating current in India is generally 50 Hz) but the poles of the magnet will continue to attract the armature.

308. Draw the diagram of the ring main circuit.

Ans : COMP 2013

Ring main circuit.



309. Electrical power P is given by the expression:

$$P = (Q \times V) \div \text{time}$$

(a) What do the symbols Q and V represent?
(b) Express 'Power' in terms of current and resistance explaining the symbols used there in.

Ans : MAIN 2008

(a) Symbols Q and V represent amount of charge passed through the conductor and potential difference applied across the ends of the conductor respectively.

NODIA

$$1\ \text{kWh} = 1\ \text{kW} \times 1\ \text{hour}$$
$$= 1000\ \text{W} \times 3600\ \text{s}$$
$$= 1000\ \text{Js}^{-1} \times 3600\ \text{s}$$
$$1\ \text{kWh} = 3.6 \times 10^6\ \text{J}$$

It is also called Board Of Trade Unit (BOTU).

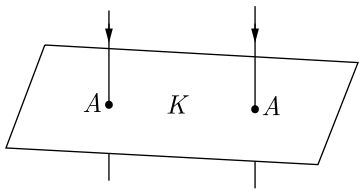
251. Distinguish between terminal potential difference and emf of a cell.

Ans : COMP 2023

(i) **Terminal potential difference :** It is the potential of the cell when a current is drawn from it. In other words, it is the potential of the cell in a closed circuit.

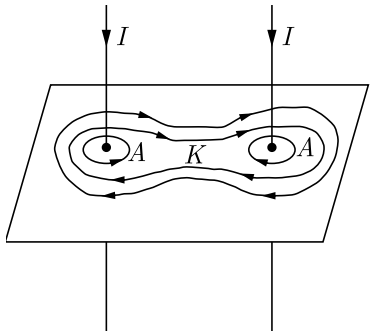
(ii) **Emf :** It is the potential of the cell when no current is drawn from it. In other words, it is the potential of the cell in an open circuit.

252. The following diagram shows two straight wires carrying current. Copy the diagram and draw the pattern of lines of force around them and mark their directions.



Ans : COMP 2023

The pattern of lines is as shown in the figure below :



253. Why it is more economical to transmit electrical energy at high voltage and low current?

Ans : SQP 2014

The loss of energy along the transmission lines is proportional to the square of current. Hence, the transmission of energy is economical at high voltage and low current.

254. Why is it more difficult to make a magnet move towards a coil which has large number of turns?

Ans : COMP 2013

Due to large number of turns large induced emf is produced. The induced emf opposes the motion of magnets. Hence, it is more difficult to move towards a coil having large number of turns.

255. What is earthing of electric appliance? Why is it essential ?

Ans : COMP 2016

Earthing is a safety device which is used to prevent the shocks due to short-circuiting and leakages. Earthing means that the metal body of the appliance is connected to a thick copper wire which is buried deep in the ground. This prevents the user from getting shocks.

256. Why is soft iron preferred to be used as the core of the electromagnet of an electric bell ?

Ans : MAIN 2016

Soft iron is chosen to make the core of the electromagnet of an electric bell on account of the following two reasons :

(i) On account of high magnetic permeability of soft iron, it can be easily magnetised and demagnetised. So it makes a strong, magnet when current flows through the solenoid but it is almost demagnetised when no current flows through the solenoid. This fact helps in the working of the electric bell.

(ii) The soft iron intensifies the magnetic field of the solenoid and so it helps in making a strong magnet.

257. Under what circumstances does one get an electric shock from an electric gadget ?

Ans : MAIN 2015

A person gets an electric shock from an electrical gadget under the following circumstances :

(i) When the outer body of an electric appliance, e.g., refrigerator, an electric geyser, an electric iron etc. is not earthed and the live wire of a faulty appliance comes in direct contact with its metallic casing due to break of insulation, the whole appliance attains the potential of the live wire and so any person touching it will get a fatal shock.

(ii) By touching a switch with wet hands, one may get a shock. In such a case water forms a conducting layer between the hand and the

Click Here to Buy book on Amazon

Resistance also depends upon the temperature of the conductor.

314. On what factors does the force experienced by a current carrying conductor placed in a uniform magnetic field depend ?

Ans : SQP 2002

The force depends upon :
(i) current through the conductor
(ii) the strength of the magnetic field and the length of the conductor.

315. Define electric power. Give its SI unit and write its mathematical equation.

Ans : COMP 2007

The rate of doing work, or the rate of dissipation of energy, is called electric power. It is denoted by P i.e.,

$$P = \frac{W}{t} = \frac{V^2}{R}$$

In SI, it is measured in watt.

316. Why is there an increase in the resistance, when two resistors are connected in series ?

Ans : MAIN 2011

When two resistors are connected in series, the effective length through which the current can pass increases. Since the resistance of a wire is given by

$$R = \rho\frac{l}{A}$$

i.e., directly proportional to the length, therefore, any increase in its length increases its resistance.

317. Score off the incorrect words and write correctly the following:
In wiring a three pin plug, the brown sleeved wire is connected to the neutral/live pin and green/ blue wire is connected to metal body of the appliance.

Ans : SQP 2012

In wiring a three pin plug, the brown sleeved wire is connected to the live pin and the green sleeved wire is connected to the metal body of the appliance.

318. State an important advantage of alternating current over direct current.

Ans : SQP 2012

An important advantage of alternating current over direct current is that electric power can be transmitted over long distances without much loss of energy.

319. Which lamp has greater resistance: a 100 W lamp or 60 W lamp when connected to the same supply?

Ans : COMP 2016

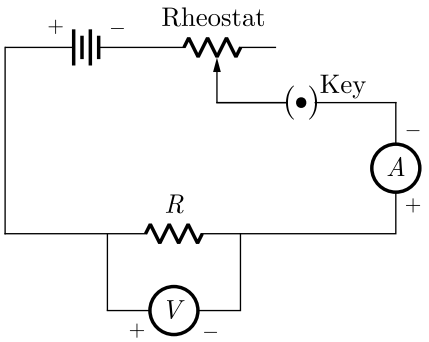
Electric power $P = \frac{V^2}{R}$ or $R = \frac{V^2}{P}$ or $R \propto \frac{I}{P}$

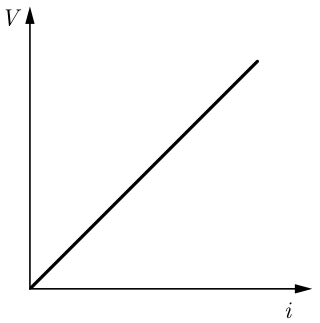
It means resistance of a lamp is inversely proportional to its power. Thus, a 60 W lamp has more resistance than 100 W lamp.

320. Draw circuit diagram to verify Ohm's law experimentally. Also show the voltage-current relationship graphically. What does the slope of $V - i$ graph represent ?

Ans : COMP 2010

Circuit diagram for verification of Ohm's law.





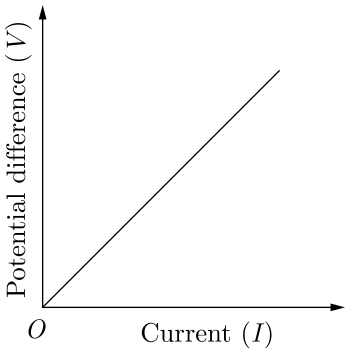
The slope of $V - i$ graph gives the resistance of the conductor/resistor.

321. Mention two factors on which the resistance of a wire depends.

Ans : MAIN 2013

Resistance of a wire is directly proportional to the length of the conductor (i.e. $R \propto l$) and inversely proportional to the area of cross-section of the wire $\left(\text{i.e. } R \propto \frac{1}{A}\right)$.

Downloaded from www.pdf.tube

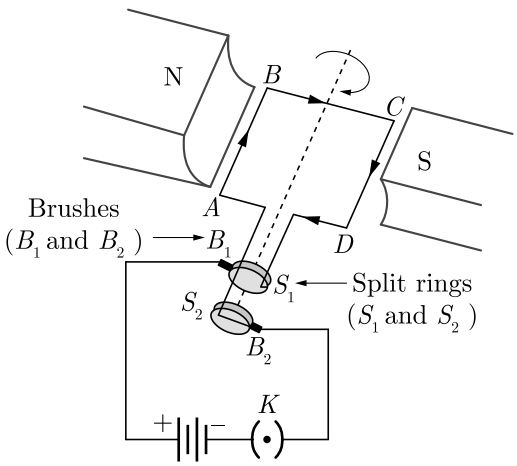


(ii) The value of the slope of the straight line gives the resistance.
(iii) The conductors which do not obey Ohm's law are non-ohmic resistors.

348. (a) Draw a simple labelled diagram of a D.C. electric motor.
(b) What is the function of the split rings in a D.C. motor?
(c) State one advantage of AC over DC.

Ans : MAIN 2013

(a)



N, S → Pole pieces B_1, B_2 → Brushes

S_1, S_2 → Split rings $ABCD$ → Armature coil.

(b) The function of the split rings in a D.C. motor is to reverse the direction of current flowing through the coil from the battery after every half a turn.
(c) A.C. voltage can be altered.

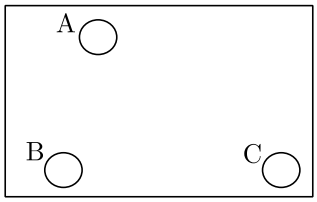
349. Define the emf (E) of a cell and the potential difference V across a resistor R in terms of work done in moving a unit charge. State the relation between these two works and the work done in moving a unit charge through a cell connected across the resistor. Take the internal resistance of the cell as r. Hence, obtain an expression for the current I in the circuit.

Ans : SQP 2001

The emf (E), of a cell, equals the work done, in moving a unit positive charge, from the positive terminal of the cell, through the external circuit, to the negative terminal of the cell and then in moving it, through the (internal) electrolyte of the cell, from the negative terminal, back to its positive terminal.
The potential difference (V), across a resistor. R, equals the work done, in moving a unit positive charge, from the higher potential end of the resistor, to its lower potential end.
Let I be the current flowing through the circuit and the cell. Then the work done, in moving a unit charge, through the internal resistance (r) of the cell, equals Ir. The relation between E, V, and this work, is

$$V = E - Ir$$

350. Three wires with proper colour coding are connected to the three terminals of a three pin socket. Match the colour of the wire with the proper terminals A, B and C of the socket.



(i) Brown
(ii) Green
(iii) Light blue

Ans : COMP 2001

(i) Colour of the wire Brown-Terminal C (Live)
(ii) Colour of the wire Green-Terminal A (Earth)
(iii) Colour of the wire Light blue-Terminal B (Neutral)

351. The relationship between the potential difference and the current in a conductor is stated in the form of a law.
(i) Name the law.
(ii) What does the slope of $V - I$ graph for a conductor represent?
(iii) Name the material used for making the connecting wire.

Ans : COMP 2015

NODIA

(i) increasing the current.
(ii) increasing the number of turns in the coil.

330. Why is the filament of the electric iron or electric kettle put between mica sheets?

Ans : COMP 2010

Mica sheet provides perfect insulation on both sides of the filament and the body of electric iron or electric kettle. It allows free flow of heat.

331. 30 bulbs are connected in series. If one bulb is fused and the remaining 29 bulbs are again joined in series and connected to the same supply. Will the light increase or decrease in the room?

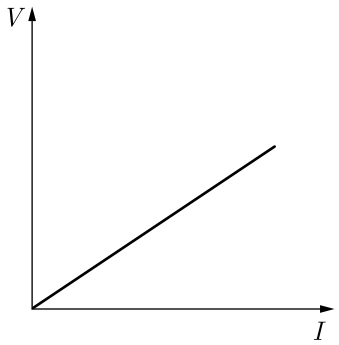
Ans : MAIN 2020

For the given supply voltage V, the power available for the series of bulbs is $\frac{V^2}{R}$ where R is the resistance of the bulbs in series. If one bulb is removed the resistance of 29 bulbs will decrease and hence the power will increase.

332. (a) Sketch a graph to show the change in potential difference across the ends of an Ohmic resistor and the current flowing in it. Label the axes of your graph.
(b) What does the slope of the graph represent ?

Ans : SQP 2011

(a)

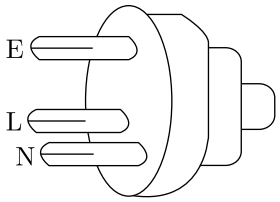


(b) Slope of the graph gives the resistance of the resistor.

333. In a three-pin plug, why is the earth pin made longer and thicker than the other two pins?

Ans : MAIN 2018

The earth pin is made thicker so that it cannot enter in live(L) or neutral(N) sockets. The earth pin is also made longer so that it gets connected to earth terminal(E) first; thus ensuring that the user will not get an electric shock.



334. What will be the effect on the working of an electric bell if instead of a direct current, an alternating current is used?

Ans : COMP 2013

Electric bell will work on direct current as well as on alternating current. Both the currents activate the electromagnet and hence soft iron is pulled. In case of alternating current, the polarity of the electromagnet rapidly changes but it has no effect on the attractive power of the electromagnet.

335. State two factors on which the strength of an induced current depends.

Ans : SQP 2001

Strength of an induced current depends on
(1) rate of change of magnetic flux within the closed coil.
(2) number of turns in coil.

336. When a solenoid that is carrying current is freely suspended, it comes to rest along a particular direction. Why does this happen?

Ans : COMP 2014

Current carrying solenoid behaves like a bar magnet, when it is suspended freely it points in north-south direction.

337. State two ways by which the emf in an A.C. generator can be increased.

Ans : SQP 2004

In an A.C. generator emf can be increased by increasing
(i) the strength of the magnetic field and
(ii) number of turns in the coil.

338. (i) A straight wire conductor passes vertically through a piece of cardboard sprinkled with iron filings. Copy the diagram and show the setting of iron filings when a current is passed through the wire in the upward direction and the cardboard is tapped gently. Draw arrows to represent the direction of the magnetic field lines.

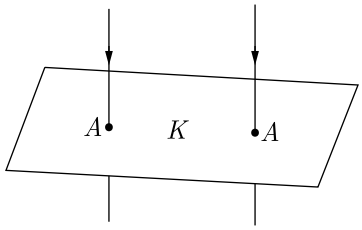
Click Here to Buy book on Amazon

322. Where is a fuse placed in an electrical circuit? Name a material suitable for making a fuse wire.

Ans : SQP 2011

The fuse is placed in the live wire just after the 'electricity meter' of the consumer. Fuse wires are generally made of an alloy of tin and lead and have a relatively low melting point and high resistance.

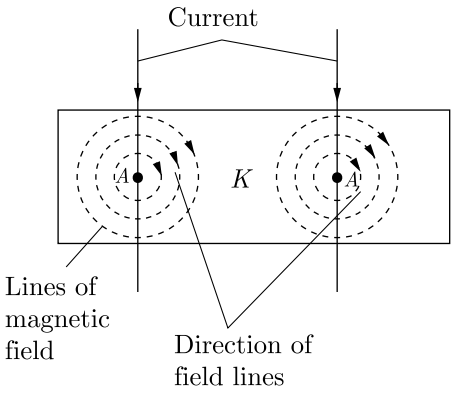
323. The following diagram shows two straight wires carrying current.



Copy the diagram and draw the pattern of lines of force around them and mark their directions.

Ans : MAIN 2022

The direction of field is given by right hand thumb rule or right handed screw rule as shown in the figure:



324. Define 1 watt and 1 kilowatt.

Ans : COMP 2005

(i) **1 watt :** An electrical appliance is said to have a power of one watt, if a current of one ampere flows through it under a potential difference of one volt.

(ii) **1 kilowatt :** It is unit of power, which is 1000 times the unit watt.

325. State the energy change which takes place when a magnet is moved inside a coil having a galvanometer at its ends. Name this phenomenon.

Ans : SQP 2005

Mechanical energy gets converted into electrical energy. The phenomenon taking place is electromagnetic induction.

326. What do the following units measure ?
(i) Coulomb and
(ii) Kilowatt hour.

Ans : SQP 2012

(i) Coulomb is the SI unit of charge.

(ii) Kilowatt hour is the commercial unit of the electrical energy.

327. A given metallic wire of resistance R is doubled on itself. What will be its new resistance?

Ans : COMP 2018

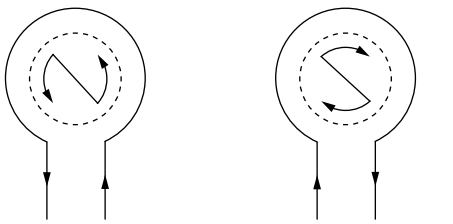
When a given metallic wire is doubled on itself, its length is reduced to half, but its area of cross-section gets doubled. So the resistance of the wire will become one-fourth.

328. How will you determine the polarity of the faces of the coil on the basis of direction of flow of current?

Ans : MAIN 2018

Polarity of the faces of the coil on the basis of direction of flow of current is determined by clock rule, i.e. look at the face of the coil, if the current around that face is in anticlockwise direction, the face has north polarity while if the current at that face is in the clockwise direction, the face has south polarity; as shown in the figure.

NODIA



329. What is an electromagnet? State two ways by which the strength of an electromagnet can be increased.

Ans : COMP 2010

If electric current is passed in a solenoid with a core of magnetic material like soft iron, the core becomes an electromagnet.

The strength of an electromagnet can be increased by

(a) Resistance of the tube 2 < resistance of the tube 1
(b) The voltmeter reading for tube 1 is the same as the voltmeter reading for tube 2.
(c) The specific resistance in both the cases is the same.

343. The voltage - current readings of a certain material are shown in the table given below:

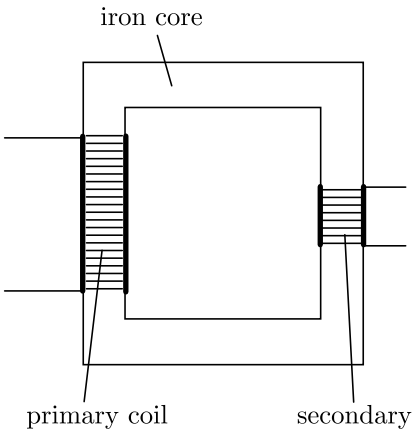
Voltage (V)	10 V	20 V	30 V
Current (I)	2 A	3 A	4 A

Study the table.
(a) State whether the conductor used is ohmic or non-ohmic.
(b) Justify your answer.
(c) State Ohm's law.

Ans : MAIN 2024

(a) Non-ohmic
(b) The resistance is not constant. It increases as voltage and current increases.
(c) The flow of current through the conductor is directly proportional to the potential difference established across the conductor provide its physical conditions (like, temperature, pressure, density, volume etc.) are constant.

344. Below is the diagram of a transformer:

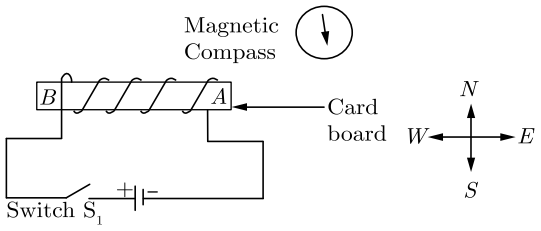


(a) Identify the type of transformer.
(b) In this type of transformer which of the wire is thicker, the primary or the secondary? Give a reason.

Ans : MAIN 2024

(a) Step down transformer
(b) Wire of secondary coil is thicker because secondary current is higher than primary current.

345. The diagram below shows a magnetic compass kept closer to a coil AB wound around a hollow cylindrical cardboard.



(i) After studying the circuit and the magnetic compass carefully, state whether the switch S_1 is open or closed.
(ii) How did you arrive at the conclusion in (i)?
(iii) What is the purpose of placing the magnetic compass in the above setup?

Ans : SEM-II 2022

(i) The switch S_1 is open because no current was going through the circuit.
(ii) As the switch does not have wire connected to the circuit. Thus, we can say that the circuit is open or the switch is open.
(iii) The purpose of placing a magnetic compass is to study the deflection and to measure the direction of current.

346. The relationship between the potential difference and the current in a conductor is stated in the form of a law.
(i) Name the law.
(ii) What does the slope of $V-I$ graph for a conductor represent?
(iii) Name the material used for making the connecting wire.

Ans : COMP 2015

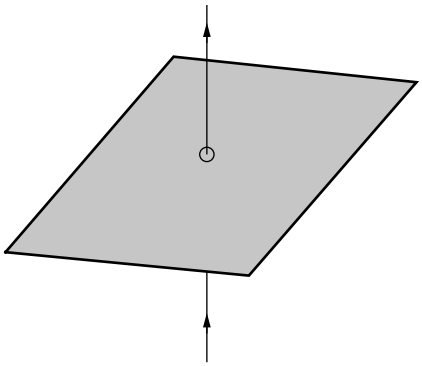
(i) Ohm's law
(ii) Resistance
(iii) Copper.

347. (i) Draw a graph of potential difference (V) versus current (I) for an ohmic resistor.
(ii) How can you find the resistance of the resistor from this graph?
(iii) What is a non-ohmic resistor?

Ans : MAIN 2011

(i)

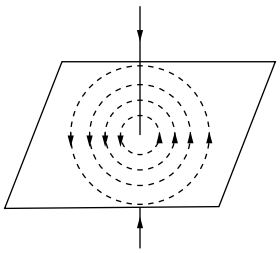
Downloaded from www.pdf.tube



(ii) Name the law which helped you to find the direction of the magnetic field lines.

Ans : MAIN 2004

(i) The direction of the magnetic lines of force will be anticlockwise. The iron filings will align themselves in circular lines of force (By Right hand thumb rule)



(ii) Right hand thumb rule or Maxwell's cork screw rule.

339. (i) State two ways by which the magnetic field of a solenoid can be made stronger.

(ii) What material is used for making the armature of an electric bell ? Give a reason for using this material.

Ans : MAIN 2017

(i) The magnetic field along the axis of a solenoid is given by

$$B = \mu_0 ni$$

Clearly, the magnetic field can be increased by :

1. increasing the current.
2. increasing the number of turns/length.

(ii) The armature of the electric bell is made of iron. This is because iron when magnetised is quickly demagnetised when the circuit is broken steel armature might lock up the circuit and the bell may not work.

340. Name two factors on which the magnitude of an induced e.m.f. in the secondary coil depends.

Ans : SQP 2001

Magnitude of an induced emf in the secondary coil depends upon

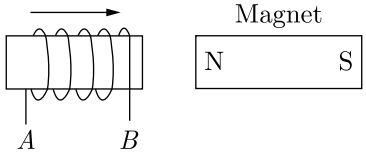
(i) The change in magnetic flux.

(ii) The time in which the magnetic flux changes

341. In the following diagram, an arrow shows the motion of the coil towards the bar magnet.

(i) State in which direction the current flows, A to B or B to A ?

(ii) Name the law used to come to the conclusion.



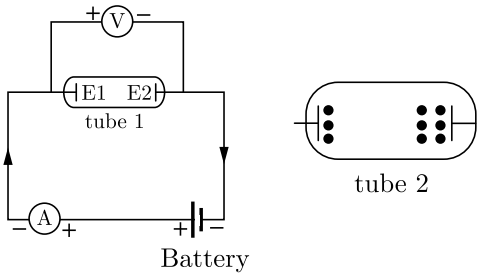
Ans : COMP 2015

(i) A to B

(ii) Lenz's law

THREE MARKS QUESTIONS

342. The circuit depicted in the figure is employed for studying Ohm's Law. Instead of using a standard resistor, a student opts for a glass tube filled with mercury (tube 1), connected to the circuit through two electrodes El & E2. He records the readings of the ammeter and voltmeter, thereby calculates the resistance. The student repeats the experiment by substituting tube 1 with tube 2, where the same amount of mercury fills the tube 2.



Neglecting internal resistance of the cell use ($>$ or $<$ or $=$) to compare

(a) the resistance in both the cases.

(b) the voltmeter readings in both the cases.

(c) the specific resistance in both the cases.

Ans : SQP 2025

NODIA

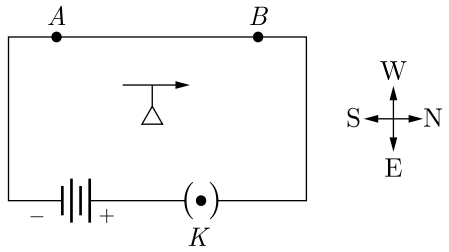
(i) Ohm's Law
(ii) Slope of $V-I$ graph for a conductor represents the resistance of the conductor.
(iii) Material used for making connecting wires is copper or aluminium.

352. A coil of copper wire is connected to a galvanometer. What would happen if a bar magnet were :
(i) pushed into the coil with its north pole entering first?
(ii) pulled out of the coil?
(iii) held stationary inside the coil?

Ans : COMP 2013

(i) There will be a change in the magnetic field (flux) linked with the coil and hence an induced emf will be produced. This will show a deflection in the needle of the galvanometer.
(ii) There will be a change in the magnetic field (flux) linked with the coil and hence an induced emf will be produced. This will show a deflection in the needle of the galvanometer opposite to the one shown in the first case.
(iii) There will be no change in the magnetic field (flux) linked with the coil and hence no induced emf will be produced. Thus, there will be no deflection in the needle of the galvanometer.

353. The diagram below shows a magnetic needle kept just below the conductor AB which is kept in North South direction.



(i) In which direction does the needle deflect when the key is closed ?
(ii) Why is the deflection produced?
(iii) What will be the change in the deflection if the magnetic needle is taken just above the conductor AB ?

Ans : MAIN 2020

(i) East.
(ii) A current carrying conductor produces a magnetic field around itself.
(iii) The direction of deflection will reverse. (Towards west)

354. There are three pins in an electric plug top. Answer the following :
(i) How would you identify the earth pin ?
(ii) In which of the three connecting wires should the electric switch be connected ?
(iii) Explain why a switch should not be touched with wet hands.

Ans : COMP 2009

(i) The earth pin is much thicker and longer than the other two pins.
(ii) The electric switch must always be connected in the 'Live wire'.
(iii) The layer of water on our hands is a good conductor of electricity. The chance of getting an electric shock, therefore, increases if the switch is touched with wet hands.

355. Explain the following:
(a) Why tungsten is used almost exclusively for filament of an incandescent bulbs?
(b) Why are the conductors of electric heating devices such as toasters and electric irons made of alloy rather than a pure metal ?
(c) Why a series arrangement is not found satisfactory for house lights ?

Ans : COMP 2010

(a) Tungsten is an alloy, as such it has a high resistivity and high melting point. Therefore, it is used exclusively in filaments of incandescent bulbs.
(b) Alloys have high resistivity and high melting point as compared to pure metals; therefore, they are used as heating elements.
(c) In case of series arrangement, if one electrical appliance fails in the circuit, the entire circuit will be switched off. Thus, series arrangement is not used in household electrical circuits.

356. What do you mean by internal resistance of a cell ? On what factors does it depend ?

Ans : SQP 2007

Internal resistance of a cell is the resistance offered by the electrolyte inside the cell to the flow of current. It is denoted by r and its unit is ohm.
Internal resistance of a cell depends upon
(i) the distance between the electrodes (more the distance more is the internal resistance).
(ii) surface area of the electrodes dipped in the electrolyte (i.e. larger the surface area, less is the internal resistance) and
(iii) the nature, concentration and temperature of the electrolyte.

Click Here to Buy book on Amazon

357. How does the resistivity of a
(i) metallic wire,
(ii) semiconductor,
(iii) an alloy such as constantan depend on temperature?

Ans : SQP 2021

(i) The resistivity of a metallic wire increases with increase in temperature.
(ii) The resistivity of a semiconductor decreases with increase in temperature.
(iii) The resistivity of an alloy almost remains unaffected with change in temperature.

358. What is heating effect of the current? Explain the cause of heat produced in a conductor when current is passed through it. State the factors on which the heat produced depends.

Ans : COMP 2006

If heat is produced in any electric appliance on passing electric current, this is known as heating effect of current.
When a potential difference is applied across the ends of a metallic conductor, the large number of free electrons in the conductor begin to drift from low potential to high potential. These electrons collide with the other electrons and-the positive ions. In these collisions, the energy of the electrons is transferred to the positive ions which begin to vibrate violently. As a result, heat is produced. The heat produced in a conductor due to passage of current depends on (i) square of the current flowing through it, (ii) resistance of the wire and (iii) the time for which the current is passed through it.

359. You are given three resistors R_1, R_2 and R_3.
If one end of each resistor is connected at one point A and other end of each resistor is connected at the other point B, and a battery is connected between these two points A and B through a key, obtain the expression for the equivalent resistance of the combination.

Ans : MAIN 2017

The given combination is a parallel combination of given resistors. In this combination, the potential difference across each resistor is same. Let it is V. The current i from the battery divides itself at point A in different arms. The resistor whose resistance is minimum carries maximum current and the resistor whose resistance is maximum carries minimum current, i.e. the current in a resistor is inversely proportional to its resistance. Let i_1, i_2 and i_3 be the currents passing through resistors R_1, R_2 and R_3 respectively. Therefore, total current $i = i_1 + i_2 + i_3$
As the potential difference between points A and B is V, so by Ohm's law,

$$i_1 = \frac{V}{R_1},\ i_2 = \frac{V}{R_2},\ i_3 = \frac{V}{R_3}$$

If the equivalent resistance of the combination between A and B is R_p then $i = \frac{V}{R_p}$

Therefore, $$\frac{V}{R_p} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Thus, in parallel combination, the reciprocal of equivalent resistance is equivalent to the sum of the reciprocals of individual resistances of given resistors.

360. What do you mean by the following terms :
(a) Potential ?
(b) Electromotive force ?
(c) Potential difference ?

Ans : COMP 2021

(a) Potential is defined as the amount of work done in bringing a single positive charge from infinity to that point. Its unit is volt.
(b) The electromotive force of a cell is equal to its chemical energy that is converted into electrical energy (or light, heat, etc.). It can be defined as the maximum potential difference across the terminals of a cell or open circuit potential difference since in that condition no energy will be lost within it. The unit of emf is volt and it is a measure of the work done by the cell per unit charge.
(c) Potential difference across a conductor is defined as the amount of work done in moving one coulomb charge from one end to the other.

$$\text{Potential difference, } (V) = \frac{\text{Work Done } (W)}{\text{Charge } (q)}$$

Its unit is also volt.

361. Explain the concept of potential difference taking the analogy of water flow.

or

Explain the concept of current taking the analogy of hydrostatic.

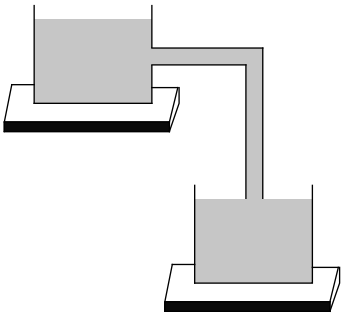
Ans : COMP 2017

Charges do not flow in a metallic wire themselves

NODIA

just as water does not flow in a horizontal pipe. Water will flow if one end of the pipe is connected to a tank of water kept at a higher level such that there is a pressure difference between the two ends of the pipe, the water flows out of the other end of the pipe.

For flow of charges in a metallic conductor there should be a difference of electric pressure called potential difference along the metallic conductor which can be produced by a cell/ battery. A chemical action within a cell generates the potential difference across the ends of the cell in the open circuit (when no current is drawn from it). When the cell is connected to a conducting element/circuit, the potential difference sets the charges in motion inside the conductor. Thus, an electric current flows in the circuit.



362. Write four differences between electromotive force and potential difference.

Ans : COMP 2021

The difference between electromotive force and potential difference are as follows:

	Electromotive force	**Potential difference**
(i)	It is the maximum potential difference between the two electrodes of the cell when the cell is in open circuit.	It is difference of potential between two points of a conductor in a closed circuit.
(ii)	It is used for the source of electric current.	It is measured between any two points of the electric circuit.
(iii)	It depends upon the nature of electrodes and the nature of electrolyte of the cell.	It depends upon the resistance between two points of the circuit and current flowing through the circuit.
(iv)	It is larger than the potential difference across any circuit element.	It is always less than emf.

363. What is earthing? What is its use?

Ans : SQP 2002

Earthing is a safety device used to prevent shocks due to -

(a) leakage; breakdown of element,

(b) short-circuiting.

Earthing means the metal body of the appliance is connected to thick copper wire, which is buried deep in moist earth and its lowered end is joined to copper plate surrounded by a mixture of common salt and charcoal.

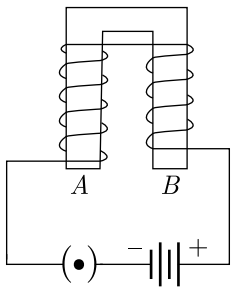
Earth terminal is connected to the body of the electric appliance. Whenever live wire touches the body of electric appliance, it gets connected to the earth through earth wire. Thus, person touching the appliance accidentally does not suffer fatal shock.

364. The diagram shows a coil wound around a U -shape soft iron bar AB.

(i) What is the polarity induced at the ends A and B when the switch is pressed?

(ii) Suggest one way to strengthen the magnetic field in the electromagnet.

(iii) What will be the polarities at A and B if the direction of current is reversed in the circuit ?



Ans : COMP 2011

(i) A North and B South.

(ii) Increasing the current through the coil.

(iii) A South and B North.

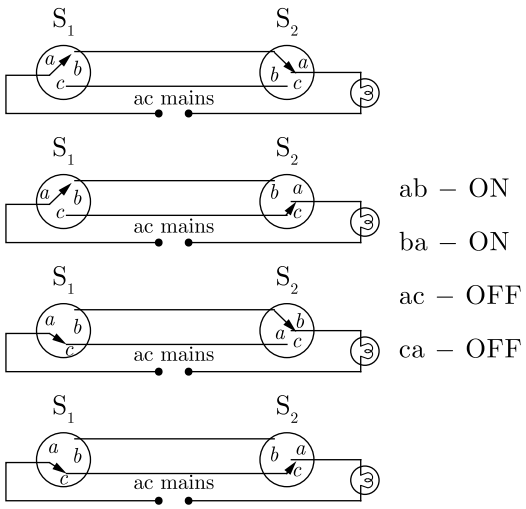
365. With the help of a diagram, explain the two way staircase wiring.

Ans : MAIN 2011

In staircase wiring double pole type or dual switches are used to switch off or on from two

NODIA

different places in a staircase. The working is illustrated in the figures:



To operate an electric bulb independently from two different positions, pair of switches are required which have three terminals a, b and c . One is to connect the live wire from the supply line. If on operating the switches S_1 and S_2, terminals ab and ba, ac and ca are connected, the bulb gets lighted. On the other hand, if ab and ca or ac and ba are connected, the circuit will not be completed and bulb will not be lighted up. Thus, we can summarise the switch position and the state of the bulb in the form of a truth table as follows.

Switch S_1	**Switch S_2**	**State of an electric bulb**
ON	ON	ON
ON	OFF	OFF
OFF	ON	OFF
OFF	OFF	ON

366. How does the resistance of a metallic wire depend on the following ?
(i) the length of wire
(ii) the thickness of wire
(iii) the temperature of wire

Ans : COMP 2000

(i) The resistance of a wire increases with increase in the length of wire

$$(R \propto l)$$

(ii) The resistance of a wire decreases with increase in its thickness or area of cross-section

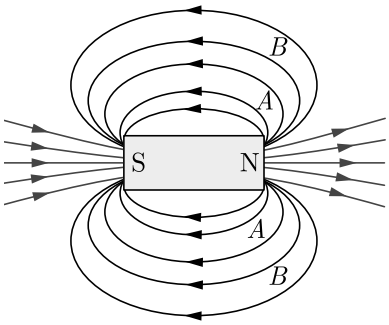
$$\left(R \propto \frac{1}{a}\right)$$

(iii) The resistance of a metallic wire increases with increase in its temperature.

367. What is a solenoid? Explain with the help of a figure how a solenoid behaves like a bar magnet?

Ans : COMP 2022

A solenoid is a cylindrical coil of many tightly wound turns of insulated wires with generally

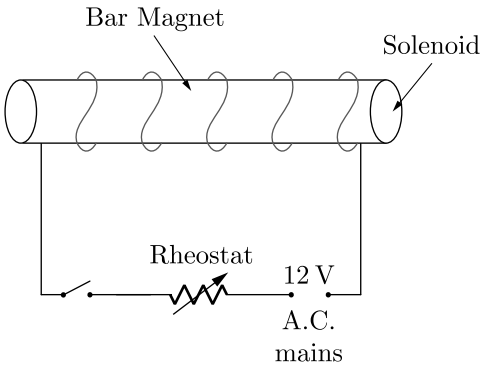


diameter of the coil smaller than its length. When a current is passed through a solenoid, a magnetic field is developed in it. As the electric current in each circular coil flows in the same direction, the magnetic field of the loop makes one end of a solenoid act as a North pole of a bar magnet and the other end as the South pole. The figure is shown above.

368. Explain briefly how a magnet can be demagnetised using an alternating current.

Ans : MAIN 2022

To demagnetise a permanent magnet, place it inside a long solenoid with its length in the east-west direction as shown in the given figure. 12 V ac supply is connected with a rheostat in series.



Switch ON the current, when alternating current is passed, its polarity changes 50 times in a second due to which magnetic domains are reversed 100 times in a second and therefore alignment varies

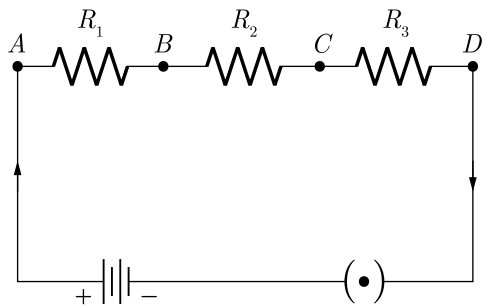
Downloaded from www.pdf.tube

after every 1/100 seconds and does not realign so fast. Thus, it becomes randomly oriented and bar loses its magnetism to a greater extent. Gradually the current is reduced to zero by rheostat which makes the realignment of domains most difficult. Thus, the bar gets completely demagnetised.

369. If three resistors R_1, R_2 and R_3 are connected end to end across the terminals of a battery through a key, what will be the equivalent resistance of the combination?

Ans : MAIN 2018

To find the equivalent resistance of given three resistors R_1, R_2 and R_3 in series combination, connect R_1, R_2 and R_3 end to end one after the other across the terminals of a battery through a key as shown in the figure.



The end of the resistor R_1 connected to the positive terminal of the battery is at a higher potential which goes on decreasing across each resistance and at the last end the potential becomes minimum i.e.

$$V_A > V_B > V_C > V_D$$

Where V_A, V_B, V_C and V_D are the potentials at points A, B, C and D respectively. In this arrangement, the current has the single path for its flow. Therefore, the same current will be passing through each resistor. If the current flowing through each resistor be i.

Using Ohm's law

$$V_A - V_B = iR_1 \quad ...(1)$$

$$V_B - V_C = iR_2 \quad ...(2)$$

$$V_C = V_D = iR_3 \quad ...(3)$$

On adding (1), (2) and (3) we get

$$V_A - V_D = iR_1 + iR_2 + iR_3 \quad ...(4)$$

If equivalent resistance between points A and D is R_S, and when i current is flowing through R_1 , R_2 and R_3, the potential difference between A and D is

$$V_A - V_D = iR_S \quad ...(5)$$

From (4) and (5)

$$iR_S = iR_1 + iR_2 + iR_3$$

i.e., $$R_S = R_1 + R_2 + R_3$$

Thus, in series combination, the equivalent resistance of given resistors is equal to sum of their individual resistances.

370. Name the rule to determine the direction of :

(i) Magnetic field produced around a current carrying conductor.

(ii) Force experienced by a straight conductor carrying current placed in a magnetic field which is perpendicular to it.

(iii) Current induced in a circuit by the changing magnetic flux due to the motion of a magnet.

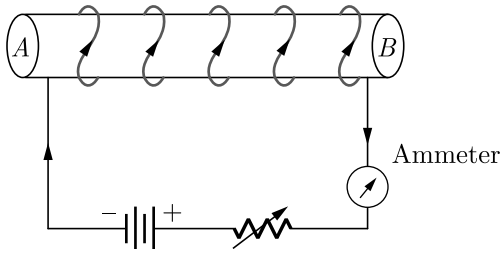
Ans : SQP 2013

(i) Right hand thumb rule.

(ii) Fleming's left hand rule.

(iii) Fleming's right hand rule

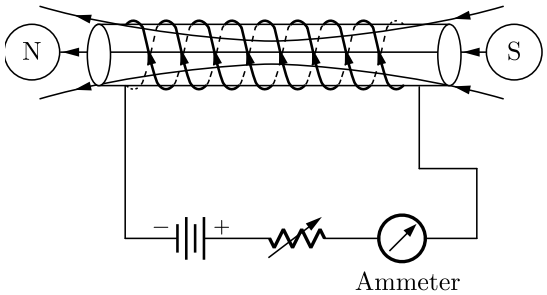
371. Diagram below shows a circuit containing a coil wound over a long and thin hollow cardboard tube. Copy the diagram. (i) Show the polarity acquired by each face of the solenoid. (ii) Draw the magnetic field lines of force inside the coil and also show their direction. (iii) Mention two methods to increase the strength of the magnetic field inside the coil.



Ans : COMP 2023

(i) The polarity acquired by the two ends is as shown below. (A shows North and B shows South polarity)

(ii)

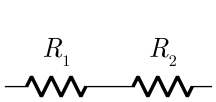
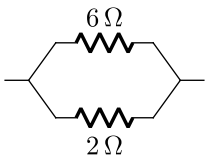


NODIA

(iii) Increase the strength of current, increase the number of turns in the coil, insert soft iron rod in the coil.

372. Distinguish between the resistors connected in series and in parallel. Giving circuit diagram.

Ans : COMP 2021

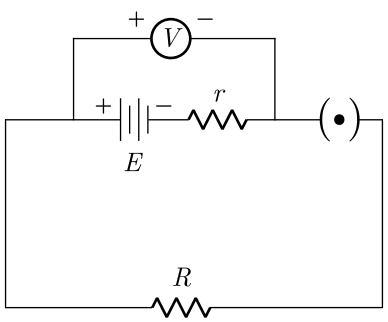
	Series combinations	**Parallel combinations**
(i)		
(ii)	In this combination, potential difference across the combination equals the sum of the potential differences across each of the resistors.	In this combination, potential difference across the combination is equal to the potential difference across any one.
(iii)	The current passing through each resistor has the same value.	The total current in the battery circuit is the sum of the currents in each resistor.

373. A cell of e.m.f. E and internal resistance r is connected in series with external resistance R . Draw a circuit diagram. Obtain an expression for the current i in terms of e.m.f. E, external resistance R and internal resistance r.

Ans : SQP 2020

From the law of conservation of energy, the total work done in moving unit charge around the circuit is equal to the sum of work done in moving unit charge across the terminals of the cell and the resistor R, i.e.

$$E = V + ir$$



But according to Ohm's law

$$V = iR$$

$$E = iR + ir$$

$$i = E/(R + r)$$

374. What do you mean by current carriers? What are current carriers in :
(i) solid conductors,
(ii) liquids,
(iii) gases ?

Ans : SQP 2020

A current flows in a circuit when charge flow in it. For the charge to flow, particles carrying charge must move. These particles are called current carriers.
(i) The current carriers in solid conductors are electrons.
(ii) In liquids the current carriers are ions.
(iii) In gases also current carriers are ions.

375. Explain briefly the function of the following in the household wiring:
(a) a three-pin plug,
(b) main switch.

Ans : MAIN 2016

(a) A three-pin plug is a device to connect any electrical gadget especially the portable one like television, vacuum cleaner, microwave oven, refrigerator to the electric supply from the house wiring. This is inserted into the socket. It has three round pins. The top pin for earth connection is longer and of greater diameter than the other two pins. This helps to insert the plug in a right way into a particular socket. The longer earth pin ensures that the earthing contact is made first before the live wire is connected to an appliance providing safety. In case of any leakage the thick earth pin conducts the charge to the earth easily and provides good earthing and due to its thickness even by mistake it cannot be inserted into the live hole of the socket.
(b) Main switch: The main switch is a double pole switch which has properly earthed iron covering. This switch is used to break the connections of the live as well as the neutral wire simultaneously.

376. Differentiate between an electromagnet and a permanent magnet.

Ans : COMP 2016

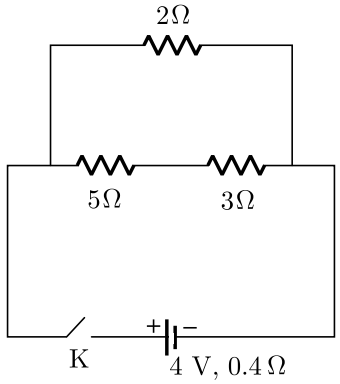
Click Here to Buy book on Amazon

The difference between electromagnet and permanent magnet :

	Electromagnet	**Permanent magnet**
(i)	It is temporary magnet. Its magnetic effect can be utilized by switching on the current when required.	It is a permanent magnet which keeps its strength for a long time.
(ii)	The strength of electromagnet can be changed by changing the number of turns in the coil or by changing the magnitude of current passing through it.	Its strength cannot be changed.
(iii)	It can produce very strong magnetic field.	Permanent magnet produces a weak field in comparison to the magnetic field produced due to an electromagnet.
(iv)	Its polarity can be changed by changing the direction of current in the coil.	Polarity is fixed.

FOUR MARKS QUESTIONS

377. Observe the given circuit diagram and answer the questions that follow :



(a) Calculate the resistance of the circuit when the key K completes the circuit.

(b) Calculate the current through 3Ω resistance when the circuit is complete.

Ans : SQP 2025

(a) $R_1 = 5 + 3 = 8\Omega$

$$R_2 = \frac{8 \times 2}{8 + 2}$$

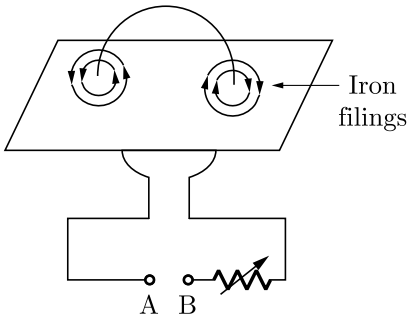
$$R_2 = 1.6\,\Omega$$

$$R = 1.6 + 0.4 = 2\,\Omega$$

(b) $$I = \frac{E}{R} = \frac{4}{2} = 2A$$

$$I_{3\Omega} = \frac{2 \times 2}{10} = 0.4A$$

378. The diagram below shows a cardboard on which iron filings are kept. A wire bent in the form of a loop is seen passing through the cardboard. When current flows through it the iron filings arrange themselves as shown below with the direction of magnetic field.



(a) State the polarities of the battery at A and B.
(b) State the effect on the magnetic field if an iron rod is held along the axis of the coil.
(c) State one way to:
1. change the polarity of the coil.
2. decrease the strength of the magnetic field around the coil.

Ans : SQP 2025

(a) A : positive and B : Negative
(b) Magnetic field becomes stronger / strength increases/magnetic flux increases /intensity of magnetic field increases or implied.
(c) 1. Interchange the polarity of the terminals of A and B / reversing the direction of the current (through the coil)
2. Decreasing the strength of the current through the coil.

NODIA
FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

These two equal, unlike and parallel forces acting on the two sides of the coil constitute a couple and thereby rotate the coil in anticlockwise direction as shown in figure (a). When the coil comes into the vertical position, i.e. normal to the plane of the paper with arm (DC up and AB down), the couple becomes zero. But due to inertia of motion, the coil passes through this position and split ring S_1 comes in contact with B_2 and S_2 comes in contact with B_1. Now the coil has rotated through 180° and the current flows through the coil in the direction $DCBA$. Now the arm DC experiences a downward force and arm BA experiences an outward force. Thus, the forces acting on the arms of the coil again form a couple due to which the coil starts rotating in an anticlockwise direction. Thus, the armature continues to rotate in anticlockwise direction.

387. Obtain the expression for the electrical energy produced in a circuit.

Ans : MAIN 2021

When the electric current is passed through a conductor, the conductor offers resistance to the flow of electric current. Therefore, some energy is required to maintain the flow of current in it which gets converted into heat energy. Therefore, to find the amount of heat produced, we find the amount of work done in sending the current through the conductor.

If on applying V volt potential difference across the ends of the conductor, i current flows it for time t. In other words, the amount of charge passed through the conductor is $Q = it$

By definition of potential,the amount of work done in moving charge Q across the ends of the conductor is

$$W = QV = i\,t\,V \qquad \{Q = it\}$$

Hence, $W = V\,i\,t$ ...(1)

by Ohm's law,

or $W = (iR)\,it$ $(V = iR)$

Hence, $W = i^2\,R\,t$ ...(2)

$$W = \left(\frac{V}{R}\right)^2 Rt \qquad \left\{i = \frac{V}{R}\right\}$$

$$W = \frac{V^2}{R}t \qquad ...(3)$$

Thus, work calculated through equations (1), (2), (3), measures the electrical energy supplied by the battery or mains in maintaining current i for time t.

388. With the help of a labelled diagram, describe the function, principle, construction and working of an A.C. generator.

Ans : COMP 2020

A.C. generator is a device used to convert mechanical energy into electrical energy. It is based upon the principle of electromagnetic induction in which e.m.f. is induced in a coil rotating in a magnetic field due to change in the number of field lines associated with the coil. The direction of current induced in the coil is given by Fleming's right hand rule.

Construction : Figure shows the essential parts of an a.c. dynamo.

Armature : A rectangular coil $ABCD$ of many turns (only one is shown in the fig.) of insulated copper wire wound on a soft iron core. The coil and its core as a whole is called as armature. The function of the coil is to increase strength of the magnetic field.

Field Magnets : The armature rotates around a spindle between pole pieces N and S of a strong magnet. Axis of rotation is perpendicular to the magnetic field lines.

Slip rings : The ends of the armature are connected to two circular rings R_1 and R_2 which are insulated from each other. The rings rotate along with the armature.

Brushes. B_1 and B_2 are two flexible metal plates or carbon rods fixed to the base of the generator and are kept pressed against rings R_1 and R_2.

Load : Brushes are connected to a load resistance R in the external circuit. Mere load means the device through which the generated current is to be passed.

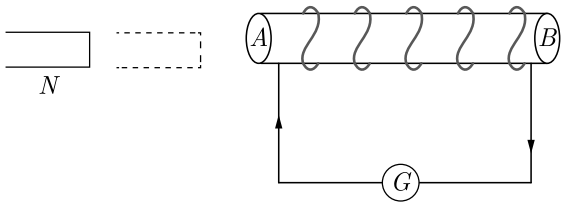
Working : Let the armature $ABCD$ is initially in the horizontal position in-the magnetic field. Now let it be rotated in the clockwise direction, the side AB of the coil moves in the upward direction and side CD moves down. According to Fleming's right hand rule, the current induced flows from A to B in the arm AB and C to D in the arm CD as shown in the fig. (a). Thus, the induced current flows in the external circuit through brush B_1 to B_2. After half the rotation of the armature, the arm AB moves down and the arm CD moves up. Now the direction of induced current in the armature is $DCBA$ while in the external circuit, current flows from B_2 to B_1 as shown in fig. (b).

Downloaded from www.pdf.tube

°C due to which the filament oxidises and evaporates quickly. Thus, to prevent oxidation and evaporation of the filament inert gas like Argon is filled in the bulb after evacuation, to increase its life.

(d) If the switch is connected in the neutral wire, the appliance remains connected to the live wire and is at the supply voltage even when the switch is off. Thus, the person who comes in contact with the live wire of the appliance, may get a fatal shock. To avoid any accident/ danger, the switch must be connected to the live wire.

382. The diagram below shows a coil connected to a centre zero galvanometer G. The galvanometer shows a deflection to the right when the N pole of a powerful magnet is moved to the right as shown.



(i) Explain why the deflection occurs in the galvanometer.

(ii) Does the direction of current in the coil appear clockwise or anticlockwise when viewed from end A ?

(iii) State the observation in G when the coil is moved away from N.

(iv) State the observation in G when, both coil and the magnet, are moved to the right at the same speed.

Ans : SQP 2007

(i) This is due to the change in magnetic flux in the coil. Due to change in magnetic flux, an induced emf is produced in the coil. Hence, a current flows through the galvanometer.

(ii) The current appears anticlockwise when viewed from end A. (because end A will form a north pole).

(iii) The galvanometer now deflects towards left.

(iv) No deflection is observed as there is no relative motion between the magnet and the coil.

383. Explain -

(i) Why is fuse always placed in the live wire ?

(ii) Why is the earth pin in a plug made longer and thicker than the other two pins ?

(iii) Why do electricians use rubber gloves ?

(iv) Why are thick wires used in the leads of an electric radiator ?

Ans : COMP 2013

(i) If the fuse is connected in the neutral wire, due to excessive flow of current, the fuse burns and current stops flowing in the neutral wire but the appliance remains connected to the live wire so the current remains flowing in the appliance. If a person touches the appliance, he/she may get severe shock.

(ii) The earth pin in a plug is made longer so that the earth connection is made first. It is made thicker so that even by mistake it cannot be inserted into the live hole of the socket.

(iii) Electricians wear rubber gloves to protect themselves from electric shocks. Rubber is a good insulator. It does not allow the current to pass through electrician's body and saves him from electric shocks if accidentally he touches the live wire.

(iv) Thick wires are used in high power instruments like electric iron, electric heater, heating rod, electric radiator because for the given voltage V,

$$P \propto i$$

Thus, the higher is the power of the electric appliance, larger is the current drawn by it and for given voltage V,

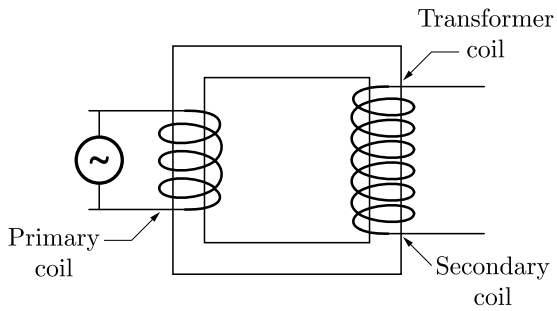
$$P \propto \frac{1}{R},$$

i.e. if resistance is low, power will be more and for low resistance, area of cross-section will be more.

384. Describe the construction and working of a simple step-up transformer.

Ans : MAIN 2013

The diagram showing the various components of a step-up transformer is given below:



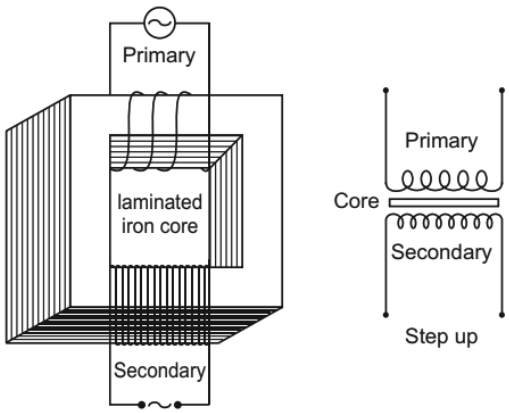
NODIA

Number of turns of secondary coil (n_s) > Number of turns of primary coil (n_p)

(i) Laminated Core is made by taking thin rectangular sheets or laminas of soft iron (or silicon-steel) and dipping them in an insulating paint or varnish. These insulated sheets are stacked together to form a solid looking rectangular frame called laminated core of the transformer.

(ii) Primary Coil is a coil of insulated copper wire wound on one arm of the 'core'. It has, n_p turns and its two terminals are connected to the a.c. source whose voltage has to be 'stepped up' or 'stepped down'.

(iii) Secondary Coil is also a coil of insulated copper wire wound on the other arm of the core [Fig. (a)]. Sometimes, the secondary coil is also wound on top of the primary coil [Fig. (b)] but with sufficient insulation between the two. The secondary coil has, say, n_s, turns and from its two terminals, we get the stepped up or stepped down A.C. voltage. The voltage available at the secondary terminals is 'stepped up' relative to the primary voltage, if $n_s > n_p$. It gets 'stepped down' if $n_s < n_p$.



(a) (b)

Working : The A.C. source, connected to the primary coil causes a varying current to flow through the coil which produces a varying magnetic field whose field lines pass through or 'thread' the secondary coil. The use of the soft iron laminated core ensures that almost all the lines of the magnetic field, produced by the primary coil, pass through or 'thread' the secondary coil. Because the magnetic field produced is a varying one, the flux linked with (i.e. the number of field lines passing through) the secondary coil is a changing one. Hence an e.m.f. is induced in the secondary coil. It can be shown that the magnitude of the (maximum) induced e.m.f. in the secondary coil is related to the corresponding magnitude of the e.m.f. in the primary coil by the relation:

$$\frac{\text{e.m.f. induced in the secondary coil } (E_s)}{\text{e.m.f. applied to the primary coil } (E_p)} = \frac{\text{No. of turns in the secondary coil } (n_s)}{\text{No. of turns in the primary coil } (n_p)}$$

It follows that if $n_s > n_p$, we have $E_s > E_p$, i.e. the transformer is a step-up transformer.

Similarly, if $n_s < n_p$, we have $E_s < E_p$, i.e. the transformer is a step-down transformer.

In an ideal transformer, where there are no energy losses, we have

Input power (primary coil)= output power (secondary coil)

Hence,
$$E_p I_p = E_s I_s$$
$$\frac{I_p}{I_s} = \frac{E_s}{E_p}$$
$$= \frac{n_s}{n_p}$$

It follows that a 'stepping up' of the voltage brings about a 'stepping down' of the current and vice versa.

385. Define the e.m.f. (E) of a cell and the potential difference (V) across a resistor (R) in terms of the work done in moving a unit charge. State the relation between these two works and the work done in moving a unit charge through a cell connected across the resistor. Take the internal resistance of tin cell as (r). Hence obtain expression for the current (i) in the circuit.

Ans : COMP 2019

E.M.F. of a cell is defined as the amount of work done in taking a unit positive charge around the complete circuit, i.e. in the wire outside the cell and in the electrolyte within the cell (It is also defined as the potential difference between the terminals of a cell when no current is drawn from it (or when the cell is in open circuit).

Potential difference or the terminal voltage of a cell is defined as the amount of work done in carrying a unit positive charge round the circuit connected across the terminals of the cell. If W is the amount of work done in moving a test charge q between the terminals of a cell through a resistor R, the potential difference $V = \frac{W}{q}$, i.e. work done in moving a unit positive charge across the terminals of the cell.

Relation between e.m.f. E, potential difference V, external resistance R and the

Click Here to Buy book on Amazon

internal resistance r.

Applying Ohm's law, for external resistance only;

$$i = V/R \quad ...(1)$$

Again applying Ohm's law, to complete circuit

$$i = \frac{E}{R+r} \quad ...(2)$$

Comparing i in (1) and (2), we have

$$\frac{V}{R} = \frac{E}{(R+r)}$$

$$ER = V(R+r)$$

$$= VR + Vr$$

$$R(E-V) = Vr$$

$$r = \frac{R(E-V)}{V}$$

$$= \frac{R(E-V)}{iR}$$

$$i = \frac{E-V}{r}$$

386. State the function of a d.c. motor. With the help of labelled diagram discuss its principle, construction and working.

Ans : MAIN 2020

D.C. motor : An electric motor is a device which converts electrical energy into mechanical energy. In electric motor, electrical energy rotates a rod called shaft. Thus, kinetic energy of the shaft and any device attached to it perform work.

Principle : It works on the principle of magnetic effect of current, i.e. when a current carrying conductor is kept normally in a magnetic field, it experiences a force as a result of which the conductor begins to move. The direction of the force is determined by Fleming's left hand rule.

Construction : Figure shows the essential parts of d.c. motor.

Armature : A rectangular coil $ABCD$ of many turns (only one is shown in the fig.) of insulated copper wire wound on a soft iron core. The coil and its core as a whop is called as armature. The function of the coil is to increase strength of the magnetic field.

Field Magnets : The armature rotates around a spindle between pole pieces N and S of a strong magnet. Axis of rotation is perpendicular to the magnetic field lines.

Commutator or Split Rings : A commutator is a copper ring split into two halves S_1 and S_2. The two ends of the coil A and D are soldered to the two halves S_1 and S_2 of a split ring commutator. The commutator rings are mounted on the shaft of the motor. They rotate when the coil rotates. The function of the commutator is to reverse the direction of current flowing through the coil from the battery.

Brushes : B_1 and B_2 are two flexible metal plates or carbon rods fixed to the base of the motor that press lightly against the two halves S_1 and S_2 of the commutator.

Battery : The battery is connected across the brushes which conveys current to the armature through the split rings.

Working : Let initially the plane of the coil is horizontal and the split ring S_1 touches the brush B_1 and the split ring S_2 touches B_2. The current flows in the coil in the direction $ABCD$. According to Fleming's left hand rule, a force F acts on the arm AB in the downward direction (into the plane of the paper) and a force F acts on the arm CD in the upward direction (outwards and perpendicular to the plane of the paper).

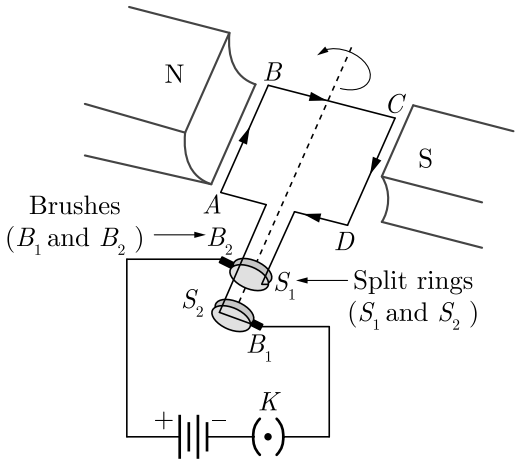


Figure (a)

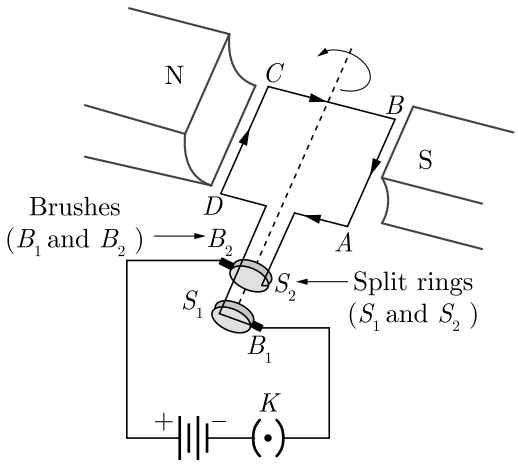
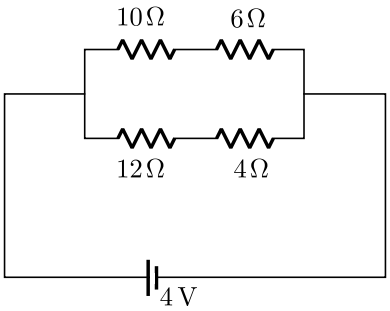


Figure (b)

Downloaded from www.pdf.tube

379. Study the diagram:



(a) Calculate the total resistance of the circuit.
(b) Calculate the current drawn from the cell.
(c) State whether the current through 10 Ω resistor is greater than, less than or equal to the current through the 12 Ω resistor.

Ans : MAIN 2024

(a) 10 Ω and 6 Ω are in series. Hence, equivalent resistance $R_1 = 16\,\Omega$.
12 Ω and 4 Ω are in series. Hence, equivalent resistance $R_2 = 16\,\Omega$.
R_1 and R_2 are in parallel. Hence, the equivalent resistance $R_{eq} = 8\,\Omega$

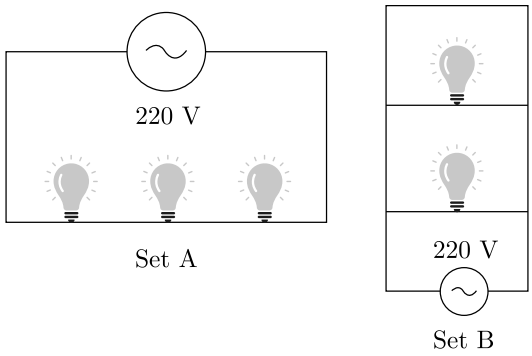
(b) $$\text{Current I} = \frac{V}{R_{eq}}$$
$$= \frac{4\,V}{8\,\Omega} = 0.5\text{ A}$$

(c) Current in both the resistors are equal because both the arms have same resistance value.

380. (i) Two sets A and B, of three bulbs each, are glowing in two separate rooms. When one of the bulbs in set A is fused, the other two bulbs also cease to glow. But in set B, when one bulb fuses, the other two bulbs continue to glow. Explain why this phenomenon occurs.
(ii) Why do we prefer arrangements of set B for house circuiting?

Ans : COMP 2014

(i) In set A, all the three bulbs are connected in series. The voltage of source gets divided in all the three bulbs connected in series, and they operate simultaneously. None of the bulb can be operated independently, and hence when one bulb fuses the other two bulbs also cease to glow. In set B, the three bulbs are connected in parallel. So even when one of the bulbs ceases to glow, the others continue to glow. Each bulb operates independently.



(ii) For house circuiting we use the set B arrangement i.e., all the appliances are connected in parallel. The advantage of connecting the appliances in parallel are:
1. Each appliance gets connected to 220 V supply for its normal working.
2. Each appliance works independently without being affected whether the other appliance is switched on or off.

Whereas when connected in series :
1. All appliances that are connected operate simultaneously and none can be operated independently.
2. Voltage of the source gets divided and on connecting one more appliance in the same circuit, the resistance of the circuit will increase. Hence, it will reduce the current in the circuit, so each appliance will get less power.

Hence, we prefer arrangements of set B for house circuiting.

381. Explain -
(a) Why is the tungsten filament used in the bulb?
(b) Why is a coiled-filament used in the bulb ?
(c) Why is the bulb filled with an inert gas ?
(d) Why are switches always placed in the live wire ?

Ans : COMP 2007

(a) Electric bulb is based on the heating effect of the current. Tungsten filament has high resistivity, high melting point ($\sim 3000^\circ$C) and is ductile. This is why it is used as a filament in the bulb.
(b) To have a high resistance, the filament wire should be long and thin $\left(\text{as } R \propto l \text{ and } R \propto \frac{1}{A}\right)$. This is why it is coiled to fit on the glass stem inside the glass bulb.
(c) When the current is passed through the filament, it gets heated upto about 2500

NODIA

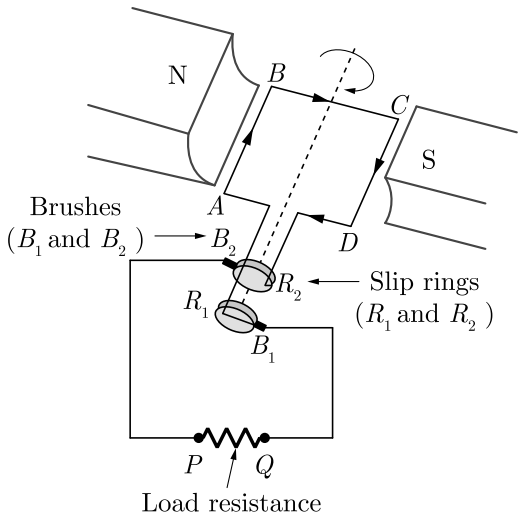


Figure (a)

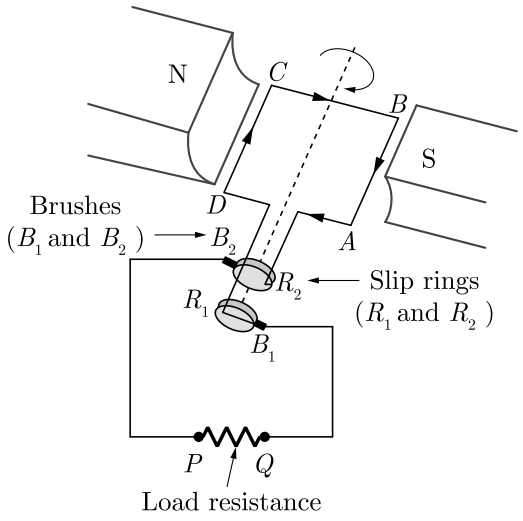


Figure (b)

Thus, in one complete rotation of the armature, in half the rotation the current induced flows in the direction $ABCD$ and in the external circuit from B_1 to B_2; in next half rotation of the armature, the induced current flows in the direction $DCBA$ and in the external circuit from B_2 to B_1. Thus in one rotation of the coil the current changes its direction twice alternately. Hence, the current induced is alternating in nature.

In India, the alternating current is produced which has a frequency of 50 Hz. i.e. the armature rotates in the magnetic field at the rate of 50 rotations per second. Since in one rotation of the armature current changes its direction twice, therefore, in 50 rotations of the armature, the current will change its direction 100 times. In other words, the alternating current changes its direction every 1/100 second.

NUMERICAL QUESTION

389. If a wire of resistance $2\,\Omega$ gets stretched to thrice its original length

(i) Calculate the new resistance of the wire.

(ii) What happens to the specific resistance of the wire?

Ans : SEM-II 2022

(i) In both the cases, the volume of the wire remains unchanged.

$$V = V'$$

$$Al = A'l' \quad \text{or} \quad A' = \frac{Al}{l'}$$

$$A' = \frac{lA}{3l} = \frac{A}{3}$$

Now, $$R = \frac{\rho l}{A}$$

and $$R' = \frac{\rho l'}{A'} = \frac{\rho 3l}{\frac{A}{3}}$$

$$= \frac{9\rho l}{A} = 9R$$

$$= 9 \times 2 = 18\,\Omega$$

(ii) Since, the specific resistance (resistivity) depends on the nature of material of the wire and is independent of the dimensions of wire, so specific resistance will not change.

390. (i) An electric bulb is marked $100\,W$, $250\,V$. What information does this convey?

(ii) How much current will the bulb draw if connected to a 250 V supply?

Ans : SQP 2011

(i) An electric bulb marked 100 W, 250 V means that when the bulb is lighted on 250 V supply, it consumes 100 W electrical power. i.e. 100 J of electrical energy is consumed in 1 s.

(ii) Current drawn $I = \frac{P}{V} = \frac{100}{250} = 0.4\,A$

391. A metal wire of resistance 6 Ω is stretched so that its length is increased to twice its original length. Calculate its new resistance.

Ans : MAIN 2013

$$R = 6\,\Omega$$

When $$\text{length} = l, \text{ area} = A$$

So, $$R = \rho\frac{l}{A}$$

Click Here to Buy book on Amazon

$$6 = \rho\frac{l}{A} \qquad ...(1)$$

When the wire is stretched

$$\text{New length} = 2l$$

Volume of the wire is remains the same.

$$Al = A'l'$$

$$Al = A'(2l)$$

$$A' = \frac{A'}{2}$$

New resistance of the wire

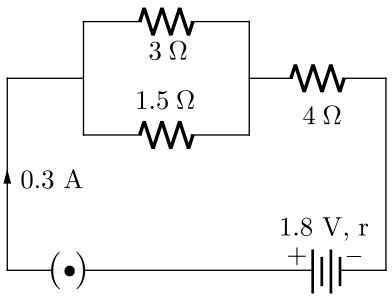
$$R' = \rho\frac{2l}{A} \times 2$$

$$= \rho\frac{l}{A} \times 4 \qquad ...(2)$$

Putting the value of $\rho\frac{l}{A} = 6$ is equation (2), we have

$$R' = 6 \times 4 = 24\,\Omega$$

392.



The diagram above shows three resistors connected across a cell of emf 1.8 V and internal resistance r.

Calculate :

(i) Current through 3 Ω resistor.

(ii) The internal resistance r.

Ans : COMP 2020

(i) $$I_3 = \frac{R_{1.5}I}{R_{1.5} + R_3}$$

$$= \frac{1.5 \times 0.3}{1.5 + 3} = 0.3\text{ A}$$

(ii) Resistors 3 Ω and 1.5 Ω are connected in parallel. Therefore, their net resistance is

$$R_P = \frac{1.5 \times 3}{1.5 + 3}$$

$$= \frac{4.6}{4.5} = 1\,\Omega$$

This is in series with the 4 Ω resistor and internal resistance of the cell r, hence total resistance of the circuit is

$$R_S = 1 + 4 + r = 5 + r$$

Now, $V = IR$, therefore, we have

$$1.8 = 0.3(5 + r)$$

$$r = 1\,\Omega$$

393. Calculate the current drawn by an appliance rated 110 W, 220 V when connected across 220 V supply.

Ans : SQP 2020

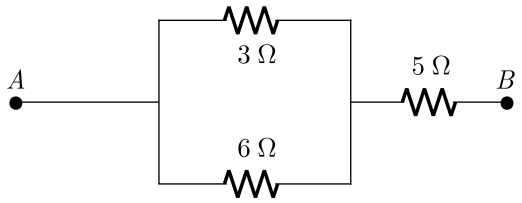
Given, Voltage = 220Volt

Power, $P = 110\text{W}$

As we know that,

$$I = \frac{P}{V} = \frac{110}{120} = 0.5\text{ A}$$

394. Calculate the total resistance across AB :



Ans : COMP 2020

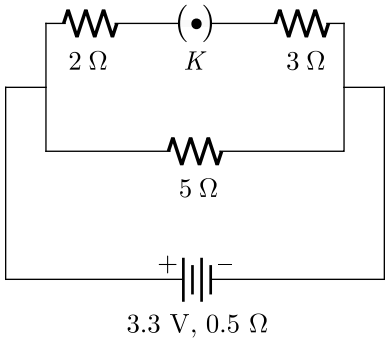
Resistors of resistances 6 Ω and 3 Ω are in parallel, therefore the equivalent resistance is given by

$$R_P = \frac{6 \times 3}{6 + 3} = 2\,\Omega$$

This is in series with the 5 Ω resistors.

Total resistance across $AB = 2 + 5 = 7\,\Omega$

395. The diagram shows a circuit with the key k open.



Calculate:

(i) the resistance of the circuit when the key k is open.

(ii) the current drawn from the cell when the key k is open.

(iii) the resistance of the circuit when the key k is closed.

(iv) the current drawn from the cell when the key k is closed.

NODIA

Ans : MAIN 2019

(i) $R_S = 5 + 0.5 = 5.5\,\Omega$

(ii) $I = \dfrac{V}{R}$

$= \dfrac{3.3}{5.5} = 0.6\text{ A}$

(iii) $R_P = \dfrac{5 \times 5}{5+5} = 2.5\,\Omega,$

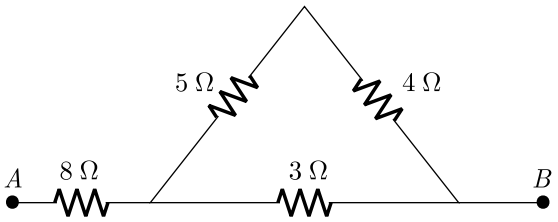
Thus total resistance is

$R_T = 2.5 + 0.5 = 3\,\Omega$

(iv) $I = \dfrac{V}{R_T}$

$= \dfrac{3.3}{3.0} = 1.1\text{ A}$

396. Calculate the effective resistance across AB :



Ans : COMP 2019

Resistors of 5 Ω and 4 Ω are in series, therefore, their net resistance is

$R_S = 5 + 4 = 9\,\Omega$

Now, this 9 Ω and 3 Ω are in parallel, hence net resistance

$R_P = \dfrac{9 \times 3}{9+3}$

$= \dfrac{18}{12} = 1.5\,\Omega$

Now, this is in series with the 8 Ω resistor, hence net resistance of the circuit is

$R_T = 8 + 1.5 = 9.5\,\Omega$

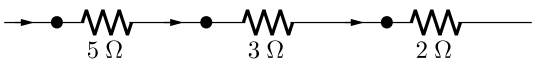
397. You have three resistors of values 2 Ω, 3 Ω and 5 Ω. How will you join them so that the total resistance is more than 7 Ω ?

(i) Draw a diagram for the arrangement.

(ii) Calculate the equivalent resistance.

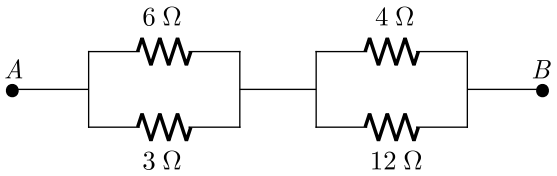
Ans : MAIN 2018

(i) All of these can be connected in series as shown:



(ii) $R = 5 + 3 + 2 = 10\,\Omega$

398. Find the equivalent resistance between A and B.



Ans : COMP 2018

6 Ω and 3 Ω are in parallel, therefore,

$R_1 = \dfrac{6 \times 3}{6+3} = \dfrac{18}{9} = 2\,\Omega$

4 Ω and 12 Ω are in parallel, therefore,

$\dfrac{4 \times 12}{4+12} = \dfrac{48}{16} = 3\,\Omega$

The above two are now in series, therefore,

$R = 2 + 3 = 5\,\Omega$

399. A fuse is rated 8 A. Can it be used with an electrical appliance rated 5 kW, 200 V? Give a reason.

Ans : SQP 2018

The current which will pass through the electrical device will be

$I = \dfrac{P}{V}$

$= \dfrac{5000}{200} = 25\text{ A}$

The fuse cannot be used as it will blow off when the current exceeds 8 A.

400. An electric iron is rated 220 V, 2 kW.

(i) If the iron is used for 2 h daily, find the cost of running it for one week if it costs ₹ 4.25 per kWh.

(ii) Why is the fuse absolutely necessary in a power circuit ?

Ans : MAIN 2018

(i) Given, $V = 220$ Volt, $P = 2\,\text{KW} = 2000\text{ W}$

As we know that,

Energy consumed,

$E = \dfrac{P(\text{in watt}) \times t(\text{in hour})}{1000}$

$= \dfrac{2000 \times 2 \times 7}{1000}$

$= 28\text{ KW h}$

Hence, cost $= 28 \times 4.25 = ₹\,119$

(ii) A fuse blows off when the maximum current in the circuit is exceeded. This helps in saving the devices connected in the circuit.

Downloaded from www.pdf.tube

401. An electric bulb of resistance $500\,\Omega$ draws a current of 0.4 A. Calculate the power of the bulb and the potential difference at its end.

Ans : COMP 2017

Given, $R = 500\,\Omega,\ I = 0.4\,\text{A},\ V = ?$

Using, $H = IR$, we have

$$V = 0.4 \times 500 = 200\,\text{V}$$

402. A music system draws a current of 400 mA when connected to a 12 V battery.

(i) What is the resistance of the music system?

(ii) The music system is left playing for several hours and finally the battery voltage drops and the music system stops playing when the current drops to 320 mA. At what battery voltage does the music system stop playing?

Ans : MAIN 2016

(i) Given, $i = 400\,\text{mA} = 0.4\,\text{A},$

$V = 12\,\text{Voltage},$

$R = ?$

$$R = \frac{V}{i} = \frac{12\,\text{V}}{0.4\,\text{A}} = 30\,\Omega$$

(ii) Given, $i = 320\,\text{mA} = 0.32\,\text{A},$

$R = 30\,\Omega,$

$V = 0.32\,\text{A} \times 30\,\Omega = 9.6\,\text{V}$

At 9.6 V music system stops playing.

403. Calculate the quantity of heat produced in a $20\,\Omega$ resistor carrying 2.5 A current in 5 minutes.

Ans : COMP 2016

Given, $R = 20\,\Omega,\ i = 2.5\,\text{A},$

$t = 5\,\text{min} = 5 \times 60\,\text{s} = 300\,\text{s}$

Quantity of heat produced,

$$H = i^2Rt$$
$$= (2.5\,\text{A})^2 \times 20\,\Omega \times 300\,\text{s}$$
$$= 37500\,\text{J}$$

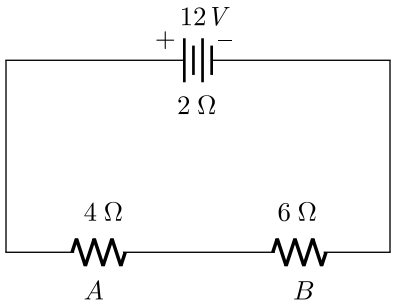
404. A battery of emf 12 V and internal resistance $2\,\Omega$ is connected with two resistors A and B of resistance $4\,\Omega$ and $6\,\Omega$ respectively joined in series. Find:

(a) Current in the circuit.

(b) The terminal voltage of the cell.

(c) The potential difference across $6\,\Omega$ Resistor.

(d) Electrical energy spent per minute in $4\,\Omega$ Resistor.



NODIA

Ans : MAIN 2016

(a) Given,

$$E = 12\,\text{V},\ r = 2\,\Omega,$$
$$R_1 = 4\,\Omega,\ R_2 = 6\,\Omega,\ i = ?$$

Current in the circuit

$$i = \frac{E}{(R_1 + R_2) + r}$$
$$= \frac{12\,\text{V}}{(4\,\Omega + 6\,\Omega) + 2\,\Omega}$$
$$= \frac{12}{12} = 1\,\text{A}$$

(b) Terminal voltage of the cell

$$\text{V}' = E - ir$$
$$= 12 - 1 \times 2 = 10\,\text{V}$$

(c) Potential difference across $6\,\Omega$ resistor

$$\text{V}' = 1\,\text{A} \times 6\,\Omega = 6\,\text{V}$$

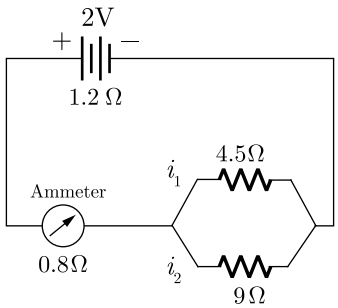
(d) Electrical energy spent per minute in $4\,\Omega$ resistor

$$= i^2Rt$$
$$= (1\,\text{A})^2 \times 4\Omega \times 60\,\text{s}$$
$$= 240\,\text{J}$$

405. A cell of emf 2V and internal resistance $1.2\,\Omega$ is connected with an ammeter of resistance $0.8\,\Omega$ and two resistors of $4.5\,\Omega$ and $9\,\Omega$ as shown in the diagram:

(a) What would be the reading on the Ammeter?

(b) What is the potential difference across the terminals of the cell?



BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!

Ans : MAIN 2015

(a) Given,

$$E = 2\,\text{V},\ r = 1.2\,\Omega,\ r_A = 0.8\,\Omega,$$

$$R_1 = 4.5\,\Omega,\ R_2 = 9\,\Omega$$

Equivalent resistance of $4.5\,\Omega$ and $9\,\Omega$ resistors

$$R = \frac{4.5\,\Omega \times 9\,\Omega}{(4.5+9)\,\Omega}$$

$$= 3\,\Omega$$

Ammeter reading, $i = \dfrac{E}{R + r + r_A}$

$$= \frac{2\,\text{V}}{(3+1.2+0.8)\,\Omega} = \frac{2}{5}A$$

$$i = 0.4A$$

(b) Potential difference across the terminals of the cell

$$V = E - ir$$

$$= 2 - 0.4 \times 1.2$$

$$= 2 - 0.48 = 1.52\,\text{V}$$

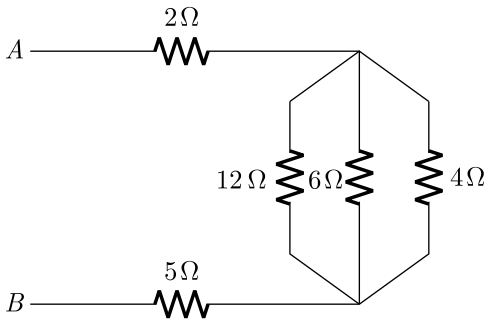
Alternate method, $V = iR'$

$$= i \times (R + r_A)$$

$$= 0.4A \times (3 + 0.8)\,\Omega$$

$$= 1.52\,\text{V}$$

406. Find the equivalent resistance between points A and B.



Ans : SQP 2015

Resistors of 4 Ω, 6 Ω and 12 Ω are in parallel, therefore, equivalent resistance of these three resistance is given by

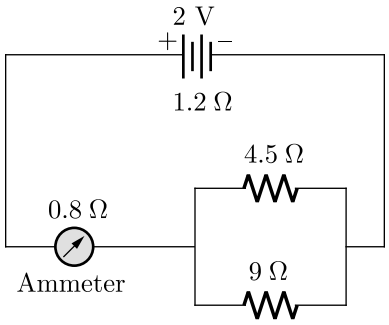
$$\frac{1}{R} = \frac{1}{4} + \frac{1}{6} + \frac{1}{12} = \frac{12}{24}$$

$$= \frac{1}{2} \text{ or } R = 2\,\Omega$$

Now, R is connected in series with 2 Ω and 5 Ω resistors, Hence equivalent resistance of the combination is

$$R_{eq} = 2 + 5 + 2 = 9\,\Omega$$

407. A cell of emf 2 V and internal resistance 1.2 Ω is connected with an ammeter of resistance 0.8 Ω and two resistors of 4.5 Ω and 9 Ω as shown in the diagram below :



(i) What would be the reading on the ammeter?

(ii) What is the potential difference across the terminals of the cell ?

Ans : MAIN 2015

(i) Here, 4.5 Ω and 9 Ω resistors are in parallel, therefore, equivalent resistance is

$$\frac{1}{R} = \frac{1}{4.5} + \frac{1}{9}$$

$$= \frac{10}{45} + \frac{1}{9} = \frac{10+5}{45}$$

$$= \frac{15}{45} = \frac{1}{3}$$

or $R = 3$ ohm

Now, ammeter and the cell are connected in series with this resistance, hence Total resistance of the circuit is

$$R_{\text{net}} = 3 + 0.8 + 1.2 = 5\,\text{ohm}$$

Hence, current through the ammeter and its reading is

$$I = \frac{V}{R_{\text{net}}} = \frac{2}{5} = 0.4\,\text{A}$$

(ii) $V = E - Ir$

$$= 2 - 0.4 \times 1.2$$

$$= 2 - 0.48 = 1.52\,\text{V}$$

408. Two resistors of 4 Ω and 6 Ω are connected in parallel to a cell to draw 0.5 A current from the cell.

(i) Draw a labelled circuit diagram showing the above arrangement.

(ii) Calculate the current in each resistor. What is an Ohmic resistor?

Ans : SQP 2014

(i) The parallel combination of two resistors 4 Ω and 6 Ω that draws a current of 0.5 A from

Click Here to Buy book on Amazon

$$= \frac{250}{625} = 0.4 \text{ A}$$

423. Two bulbs are marked 100 W, 220 V and 60 W, 110 V. Calculate the ratio of their resistances.

Ans : COMP 2011

We know that $R = \frac{V^2}{P}$

The resistance R_1 of the first bulb,

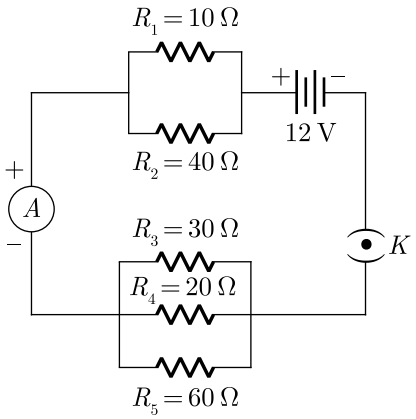
$$R_1 = \frac{220 \times 220}{100} = 484\ \Omega$$

and $$R_2 = \frac{110 \times 110}{60}$$

$$= \frac{1210}{6} = 201.67\ \Omega$$

$$\frac{R_1}{R_2} = \frac{484}{1210} \times 6 = 2.4 : 1$$

424. Five resistors of different resistances are connected together as shown in the figure. A 12 V battery is connected to the arrangement.



Calculate :

(i) the total resistance in the circuit.

(ii) the total current flowing in the circuit.

Ans : MAIN 2010

(i) Here we find that R_1 and R_2 are in parallel and their combined resistance, R' is given by

$$R' = \frac{10 \times 40}{10 + 40} = 8\ \Omega$$

Also, the resistances of 30 Ω, 20 Ω and 60 Ω are in parallel, and their combined resistance R'' is given by

$$\frac{1}{R''} = \frac{1}{30} + \frac{1}{20} + \frac{1}{60}$$

$$= \frac{2 + 3 + 1}{60} = \frac{6}{60}$$

Hence, $R'' = \frac{60}{6} = 10\ \Omega$

Now, R' and R'' are in series and their combined resistance R is given by

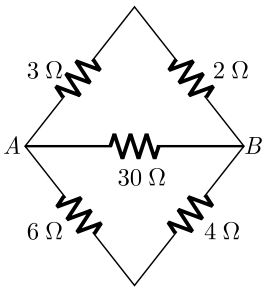
$$R = R' + R''$$

$$= 8 + 10 = 18\ \Omega$$

(ii) Now, $I = \frac{V}{R}$

$$= \frac{12}{18} = \frac{2}{3} \text{ A} = 0.67 \text{ A}$$

425. Calculate the equivalent resistance between A and B from the following diagram :



Ans : MAIN 2011

It is clear from the figure, the combination of 3 Ω and 2 Ω in series and that of 6 Ω and 4 Ω are in parallel with 30 Ω.

$$R_1 = 3 + 2 = 5\ \Omega$$

$$R_2 = 30\ \Omega$$

$$R_3 = 6 + 4 = 10\ \Omega$$

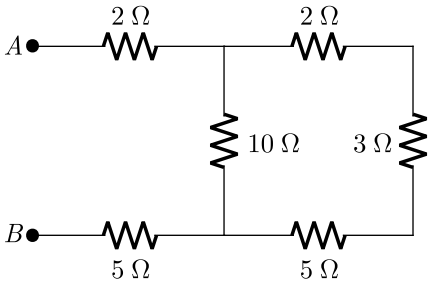
Hence, $$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R} = \frac{1}{5} + \frac{1}{30} + \frac{1}{10}$$

$$\frac{1}{R} = \frac{6 + 1 + 3}{30}$$

$$R = 3\ \Omega$$

426. Six resistances are connected together as shown in the figure. Calculate the equivalent resistance between the point A and B.



Ans : COMP 2010

NODIA

(b) Let the current $i = 0.5\,\text{A}$ be distributed in the two resistors $R_1 = 4\Omega$ and $R_2 = 6\Omega$ as i_1 and i_2 respectively.

i.e. $$i = i_1 + i_2$$

or $$0.5 = i_1 + i_2 \quad ...(1)$$

As R_1 and R_2 are in parallel, the potential difference across them will be the same.

i.e. $$i_1 R_1 = i_2 R_2$$

$$i_1 \times 4\Omega = i_2 \times 6\Omega$$

$$i_1 \times 4\Omega = 0.5 \times 6 - 6i_1$$

(from eq. (1), $i_2 = 0.5 - i_1$)

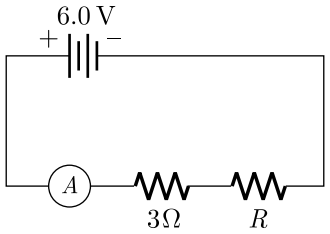
$$4i_1 = 0.5 \times 6 - 6i_1$$

$$10i_1 = 3$$

$$i_1 = 0.3\,\text{A}$$

$$i_2 = 0.5 - 0.3 = 0.2\,\text{A}$$

412. The figure shows a circuit:



When the circuit is switched ON, the ammeter reads 0.5 A.

(i) Calculate the value of the unknown resistor R.

(ii) Calculate the charge passing through the $3\,\Omega$ resistor in 120 s.

(iii) Calculate the power dissipated in the $3\,\Omega$ resistor.

Ans : MAIN 2013

(i) As we know that,

$$i = \frac{E}{R_1 + R_2}$$

$$0.5 = \frac{6\,V}{3 + R_2}$$

Hence, $$R = R_2 = 9\Omega$$

(ii) Charge, $q = it$

$$= 0.5\,\text{A} \times 120\,\text{s}$$

$$= 60.0\,\text{C}$$

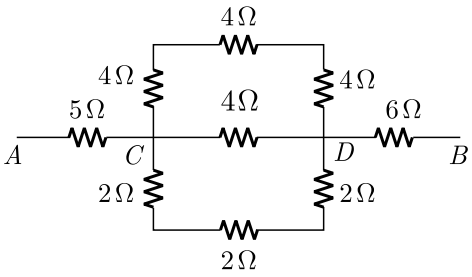
(iii) Power dissipated in 3Ω resistor,

$$P = i^2 R$$

$$= (0.5\,\text{A})^2 \times 3\Omega$$

$$= 0.25 \times 3 = 0.75\,\text{W}$$

413. Calculate the equivalent resistance between the points A and B for the following combination of resistors :



Ans : COMP 2013

Let equivalent resistance between C and D be R_{CD}

According to the diagram,

$$\frac{1}{R_{CD}} = \frac{1}{(4\Omega + 4\Omega + 4\Omega)} + \frac{1}{4\Omega} + \frac{1}{(2\Omega + 2\Omega + 2\Omega)}$$

$$\frac{1}{R_{CD}} = \frac{1}{12\Omega} + \frac{1}{4\Omega} + \frac{1}{6\Omega}$$

$$= \frac{1 + 3 + 2}{12}$$

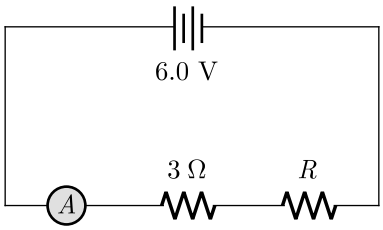
$$R_{CD} = 2\Omega$$

Equivalent resistance between the points A and B

$$R_{AB} = 5\,\Omega + R_{CD} + 6\,\Omega$$

$$= 5\,\Omega + 2\,\Omega + 6\,\Omega = 13\,\Omega$$

414. The figure shows a circuit :



When the circuit is switched on, the ammeter reads 0.5 A

(i) Calculate the value of the unknown resistor R.

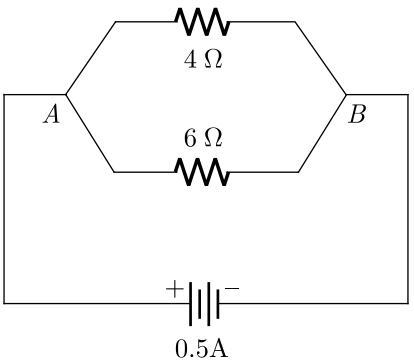
(ii) Calculate the charge passing through the 3 Ω resistor in 120 s.

(iii) Calculate the power dissipated in the 3 Ω resistor.

Ans : MAIN 2013

(i) As $V = IR$ (Total R)

the cell is as shown below.



(ii) Current in resistor of 4 Ω is

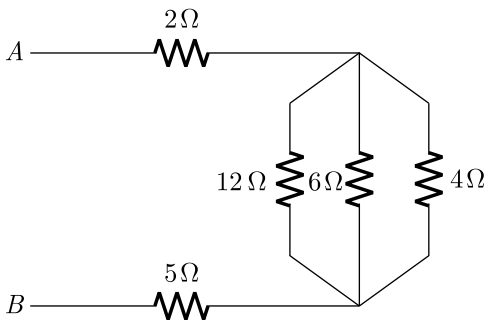
$$I_4 = \frac{6 \times 0.5}{6+4}$$

$$= \frac{3}{10} = 0.3\ \text{A}$$

Since current is distributed amongst the two resistors, therefore, current in resistor of 6 Ω is

$$I_6 = 0.5 - 0.3 = 0.2\ \text{A}$$

409. Find the equivalent resistance between points A and B.



Ans : COMP 2015

Let the equivalent resistance between points A and B is R.

$$R = R_1 + R_2 + R_3$$

where $R_1 = 2\Omega$

$R_2 =$ equivalent resistance of 4Ω, 6Ω and 12Ω resistors

i.e. $$\frac{1}{R_2} = \frac{1}{4} + \frac{1}{6} + \frac{1}{12}$$

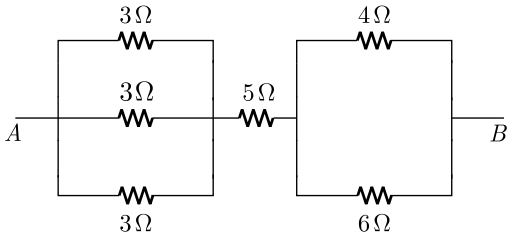
$$\frac{1}{R_2} = \frac{3+2+1}{12}$$

$$R_2 = \frac{12}{6}$$

$$R_2 = 2\Omega$$

$$R_3 = 5\Omega$$

410. Find the equivalent resistance between points A and B.



Ans : COMP 2014

In points A and B three sets of resistances are connected in series in which first three resistances of 3Ω each are connected in parallel and it is connected to 5Ω resistances in series which is further connected in series to a set of two resistances of 4Ω and 6Ω connected in parallel, i.e.

$$\frac{1}{R_I} = \frac{1}{3\Omega} + \frac{1}{3\Omega} + \frac{1}{3\Omega}$$

$$\frac{1}{R_I} = \frac{1+1+1}{3}$$

$$R_I = 1\Omega$$

$$R_{II} = 5\Omega$$

$$R_{III} = \frac{4\Omega \times 6\Omega}{(4+6)\Omega}$$

$$= \frac{24}{10}\Omega = 2.4\Omega$$

Equivalent resistance between points A and B

$$= R_I + R_{II} + R_{III}$$

$$= 1\Omega + 5\Omega + 2.4\Omega = 8.4\Omega$$

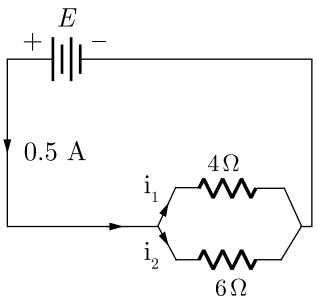
411. Two resistors of 4Ω and 6Ω are connected in parallel to a cell to draw 0.5 A current from the cell.

(a) Draw a labelled circuit diagram showing the above arrangement.

(b) Calculate the current in each resistor.

Ans : SQP 2014

(a)

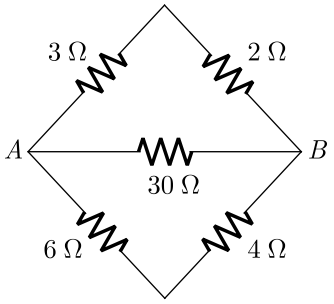


Downloaded from www.pdf.tube

$$\frac{(220)^2}{100}:\frac{(110)^2}{60}=\frac{220\times220}{100}:\frac{110\times110}{60}$$

$$=12:5$$

419. Calculate the equivalent resistance between A and B from the following diagram:



Ans : COMP 2011

In the above circuit diagram the resistors are connected in the series combination therefore the equivalent resistance is given by

$$R_1=3\,\Omega+2\,\Omega\ =5\,\Omega$$

$$R_2=6\,\Omega+4\,\Omega\ =10\,\Omega$$

Now, R_1,and R_2 are connected in parallel combination therefore its equivalent resistance is given by

$$\frac{1}{R_p}=\frac{1}{5}+\frac{1}{30}+\frac{1}{10}$$

$$=\frac{6+1+3}{30}=\frac{10}{30}$$

Hence, $R=3\,\Omega$

420. A metal wire of resistance 6Ω is stretched so that its length is increased to twice its original length. Calculate its new resistance.

Ans : MAIN 2013

Resistance of wire, $R=\frac{\rho l}{A}$

$$6\,\Omega=\frac{\rho l}{A}$$

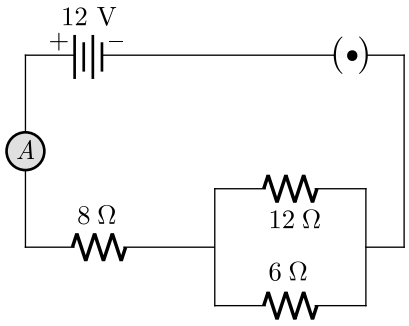
On stretching the wire

$$l_2=2l,\ A_2=\frac{1}{2}A$$

$$R_2=\frac{\rho(2l)}{\frac{1}{2}A}=2\times2\frac{\rho l}{A}$$

$$=2\times2\times6\ =24\Omega$$

421. Three resistors are connected to a 12 V battery as shown in the figure given below :



(i) What is the current through the 8 ohm resistor ?

(ii) What is the potential difference across the parallel combination of 6 ohm and 12 ohm resistor ?

(iii) What is the current through the 6 ohm resistor ?

Ans : SQP 2011

(i) Resistance of 12 Ω, 6 Ω parallel combination

$$=\frac{12\times6}{18}=4\,\Omega$$

The combined resistance of the circuit

$$=8+4\ =12\,\Omega$$

Hence, Current through $8\,\Omega$ resistance

$$=\frac{12\text{ V}}{12\,\Omega}=1\text{ A}$$

(ii) Potential difference across the $12\,\Omega-6\,\Omega$ parallel combination

$$=4\times1\ =4\text{ V}$$

(iii) Current through $6\,\Omega$ resistor

$$=\frac{1\times12}{6+12}$$

$$=\frac{12}{12}=\frac{2}{3}\text{ A}$$

422. (i) An electric bulb is marked 100 W, 250 V. What information does this convey ?

(ii) How much current will the bulb draw if connected to a 250 V supply ?

Ans : SQP 2011

(i) $P=100\text{ W}$

$V=250\text{ Volt}$

It tells us that it will consume 100 watt at 250 V.

(ii) $R=\frac{V^2}{P}$

$$=\frac{250\times250}{100}=625\,\Omega$$

$$I=\frac{V}{R}$$

NODIA

$$R_p = 3\,\Omega$$

Total $R = 3\,\Omega$,

$$\frac{V}{R} = \frac{6}{3} = 2\text{ A}$$

Current, $I = 2$ A

430. Calculate the quantity of heat that will be produced in a coil of resistance 75 Ω, if a current of 2 A is passed through it for 2 minutes.

Ans : SQP 2010

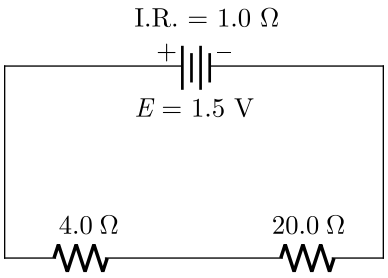
Given, $R = 75\,\Omega;\ I = 2$ A

$t = 2$ min. $= 2 \times 60 = 120$ s

Now, heat produced

$$H = I^2Rt$$
$$= 2 \times 2 \times 75 \times 120\text{ J}$$
$$= 36000\text{ J}$$

431. A cell of emf 1.5 V and internal resistance 1.0 Ω is connected to two resistors of 4.0 Ω and 20.0 Ω in series as shown in the figure:



(i) current in the circuit.
(ii) potential difference across the 4.0 ohm resistor.
(iii) voltage drop when the current is flowing.
(iv) potential difference across the cell.

Ans : SQP 2007

Given, $E = 1.5$ V, $r = 1.0\,\Omega$,

$r_1 = 4.0\,\Omega$, $r_2 = 20\,\Omega$

Since r_1 and r_2 and in series, their total resistance $= 4 + 20 = 24\,\Omega$

Hence, Total current resistance

$$= 24 + 1 = 25\,\Omega$$

(i) Hence, Current in the circuit

$$= \frac{1.5}{25} = 0.06\text{ A}$$

(ii) Potential difference across 4.0 Ω resistor

$$V = Ir = 0.06 \times 4 = 0.24\text{ V}$$

(iii) Voltage drop across the cell when the current is flowing

$$= 1.0 \times 0.06 = 0.06\text{ V}$$

(iv) Potential difference across the cell

$$= 1.5\text{ V} - 0.06\text{ V} = 1.44\text{ V}$$

432. Calculate the value of the resistance which must be connected to a 15 Ω resistance to provide an effective resistance of 6 Ω.

Ans : MAIN 2007

Given, $R_P = 6\,\Omega$, $r_1 = 15\,\Omega$, $r_2 = ?$

As we know that,

$$\frac{1}{R_P} = \frac{1}{r_1} + \frac{1}{r_2}$$
$$\frac{1}{6} = \frac{1}{15} + \frac{1}{r_2}$$
$$\frac{1}{r_2} = \frac{1}{6} - \frac{1}{15}$$
$$= \frac{5-2}{3} = \frac{3}{30} = \frac{1}{10}$$
$$r_2 = 10\,\Omega$$

433. Find the cost of operating an electric toaster for two hours, if it draws 8 A current on a 110 V circuit. The cost of electrical energy is ₹ 2.50 per kWh.

Ans : COMP 2006

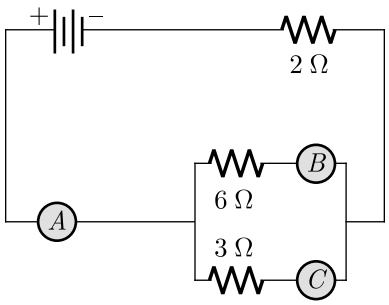
Here, $I = 8$ A, $V = 110$ Volt, $t = 2$ h

Energy consumed in 2 hours $= VIt$

$$= 110 \times 8 \times 2\text{ Wh}$$
$$= \frac{110 \times 8 \times 2}{1000}\text{ KWh}$$
$$= 1.76\text{ KWh}$$

Expenses $= 1.76 \times 2.5 =$ ₹ 4.40

434. In the figure given below A, B and C are three ammeters. The ammeter B reads 0.5 A. (All the ammeters have negligible resistance.) Calculate :
(i) the readings in the ammeters A and C.
(ii) the total resistance of the circuit.

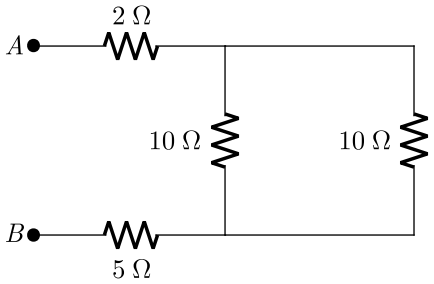


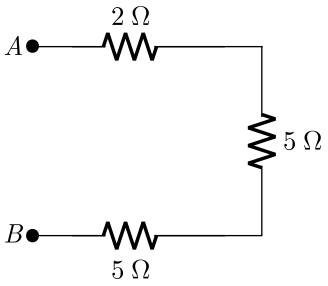
Click Here to Buy book on Amazon

Clearly, the resistance of 2 Ω, 3 Ω and 5 Ω are in series.
Hence,

Total resistance $R_s = 2 + 3 + 5 = 10\,\Omega$

The circuit reduces to as shown





Now, 10 Ω and 10 Ω are in parallel, there combined resistance R' is

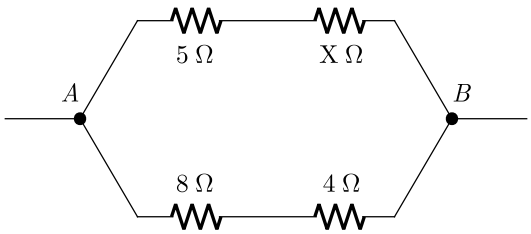
$$\frac{1}{R'} = \frac{1}{10} + \frac{1}{10} = \frac{2}{10}$$

Hence, $R' = 5\,\Omega$

Now, 2 Ω, 5 Ω, 5 Ω are in series, therefore the net resistance is

$$R = 2 + 5 + 5$$
$$= 12\,\Omega$$

427. The equivalent resistance of the following circuit diagram is 4 Ω Calculate the value of x.



Ans : MAIN 2009

$\frac{1}{5+x} + \frac{1}{12} = \frac{1}{4}$ (As 5 Ω and $x\,\Omega$ are in series and 8 Ω and 4 Ω are in series, and total R in parallel is 4 Ω
Hence, $5 + x$ and $8 + 4$ are in parallel)

$$\frac{1}{5+x} = \frac{1}{4} - \frac{1}{12} - \frac{3-1}{12}$$
$$= \frac{2}{12} = \frac{1}{6}$$
$$\frac{1}{5+x} = \frac{1}{6}$$
$$6 = 5 + x$$

Hence, $x = 1\,\Omega$

428. An electric heater is rated 1000 W - 200 V. Calculate:
(i) the resistance of the heating element.
(ii) the current flowing through it.

Ans : COMP 2009

Given,

Power of heater = 1000 W

Potential difference (P.D.) = 200 V, $R = ?$, $I = ?$

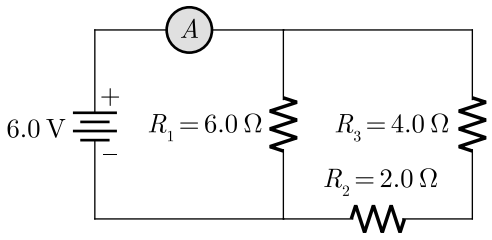
$$P = \frac{V^2}{R}$$

or $$R = \frac{V^2}{P}$$
$$= \frac{200 \times 200}{1000} = 40\,\Omega$$

Again, $$V = IR$$
$$200 = I \times 40$$
$$I = 5\,\text{A}$$

429. Three resistors of 6.0 Ω, 2.0 Ω and 4.0 Ω respectively are joined together as shown in the figure. The resistors are connected to an ammeter and to a cell of emf 6.0 V. Calculate :
(i) the effective resistance of the circuit.
(ii) the current drawn from the cell.

NODIA



Ans : COMP 2009

As R_3 and R_2 are in series.

Hence, $R_S = 4 + 2 = 6\,\Omega$

and R_1 is in parallel to its combination

Hence, $$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_S}$$
$$= \frac{1}{6} + \frac{1}{6} = \frac{1}{3}$$

So,Total resistance, $R = \frac{V}{I}$

$= \frac{6}{0.5} = 12\,\Omega$

Hence, R in circuit $= 12 - 3 = 9\,\Omega$ (as both are in series)

$R = 9\,\Omega$

(ii) Charge = Current × Time

$= 0.5 \times 120 = 60\,\text{C}$

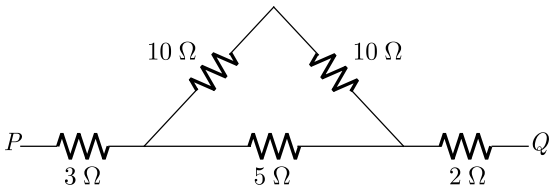
(iii) Power dissipated in $3\,\Omega$ resistor

$= I^2R$

$= 0.5 \times 0.5 \times 3$

$= 0.75\,\text{W}$

415. Calculate the equivalence resistance between P and Q from the following diagram:



Ans : COMP 2012

Equivalent resistance between P and Q

$= 3\,\Omega + \frac{(10+10)\,\Omega \times 5\,\Omega}{(10+10)+5\,\Omega} + 2\,\Omega$

$= 3\,\Omega + 4\,\Omega + 2\,\Omega$

$= 9\,\Omega$

416. An electrical appliance is rated at 1000 kVA, 220 V. If the appliance is operated for 2 hours, calculate the energy consumed by the appliance in:
(i) kWh
(ii) joule

Ans : SQP 2012

Given, $P = 1000$ kVA $= 1000$ kW, $t = 2$ h

(i) Energy consumed by the appliance,

$E = P \times t$

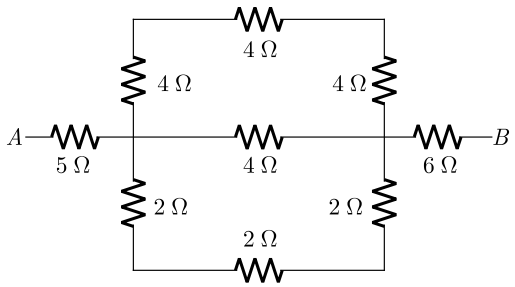
$= 1000\,\text{KW} \times 2\,\text{h}$

$= 2000\,\text{KW h}$

(ii) Energy (in joules) $= 2000 \times 3.6 \times 10^6\,\text{J}$

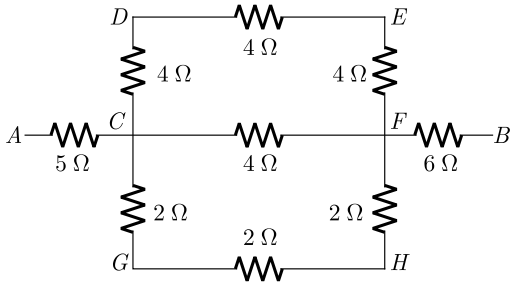
$= 7.2 \times 10^9\,\text{J}$

417. Calculate the equivalent resistance between the points A and B for the following combination of resistors :



Ans : MAIN 2013

As in the circuit at position C, current goes through three different paths which are parallel to each other.



1st path $CDEF$
2nd path $CGHF$
3rd path CF
Resistance of 1st path

$CDEF = 4\,\Omega + 4\,\Omega + 4\,\Omega$

$= 12\,\Omega$

Resistance of 2nd path

$CGHF = 2\,\Omega + 2\,\Omega + 2\,\Omega$

$= 6\,\Omega$

Resistance of 3rd path

$CF = 4\,\Omega$

So, $\frac{1}{T.R} = \frac{1}{12} + \frac{1}{6} + \frac{1}{4}$

$= \frac{1+2+3}{12} = \frac{6}{12} = \frac{1}{2}$

So, $T.R.$ in parallel $= 2\,\Omega$
Now, AC and FB are in series.
Hence, Total resistance $= 5\,\Omega + 2\,\Omega + 6\,\Omega = 13\,\Omega$

418. Two bulbs are marked 100 W, 220 V and 60 W, 110 V. Calculate the ratio of their resistances.

Ans : SQP 2016

As, $R = \frac{V^2}{P}$

$R_1 : R_2 = \frac{V_1^2}{P_1} : \frac{V_2^2}{P_2}$

Downloaded from www.pdf.tube

Ans : COMP 2005

(i) The current in the ammeters B and C is inversely proportional to the value of resistance in the parallel branch. Therefore,

$$\frac{\text{reading of ammeter } C}{\text{reading of ammeter } B} = \frac{6}{3} = 2$$

Therefore, reading of ammeter C

$$= 2 \times 0.5 = 1.0 \text{ A}$$

Hence, reading of ammeter

$$A = (0.5 + 1.0)$$

$$A = 1.5 \text{ A}$$

(ii) Let the total resistance of the circuit be R Therefore,

$$R = 2 + R_{P'} \text{ where}$$

$$\frac{1}{R_P} = \frac{1}{3} + \frac{1}{6} = \frac{1}{2}$$

$$R_P = 2 \text{ ohm}$$

Therefore, $R = 2 + 2 = 4$ ohm

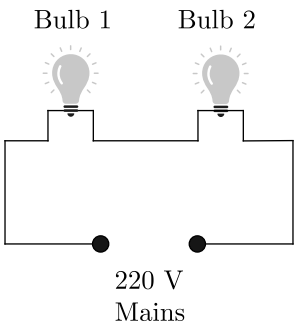
435. An electric bulb rated 220 V, 60 W is working at full efficiency.

(a) Find the resistance of the coil of the bulb.

(b) Another identical bulb is connected in series with the first one and the system is connected across the mains as shown in figure :

(i) State the rate of conversion of energy in each bulb.

(ii) What will be the total power, if the bulbs are connected in parallel ?



Ans : MAIN 2004

Given, $P = 60$ W, $V = 220$ Volt

(a) Using $P = \frac{V^2}{R}$, we have

$$R = \frac{V^2}{P} = \frac{(220)^2}{60}$$

$$= \left(\frac{2420}{3}\Omega\right) = 806.7\,\Omega$$

(b) (i) When connected in series, the total resistance of the circuit becomes

$$R_T = 806.7 + 806.7 = 1613.4\,\Omega$$

$$= R_T = \frac{4840}{3}\,\Omega$$

Therefore, current through the two bulbs

$$I = \frac{V}{R_T} = \frac{220}{4840} \times 3 = \frac{3}{22} \text{ A}$$

$$= 0.14 \text{ A}$$

$$H = I^2 R$$

$$= \frac{3}{22} \times \frac{3}{22} \times \frac{2420}{3}$$

$$= 15 \text{ W}$$

$$I = \frac{V}{R_T} = \frac{220}{1613.4} \simeq 0.14 \text{ A}$$

Therefore, rate of conversion of energy in each bulb

$$H = I^2 R = (0.14)^2 \times 806.7$$

$$= 15.8 \text{ Js}^{-1} \simeq 15 \text{ W}$$

(ii) When bulbs are connected in series, the total power consumed is

$$\frac{1}{P} = \frac{1}{P_1} + \frac{1}{P_2}$$

$$= \frac{1}{60} + \frac{1}{60} = \frac{1}{30}$$

$$P = 30 \text{ W}$$

In parallel, $P = P_1 + P_2$

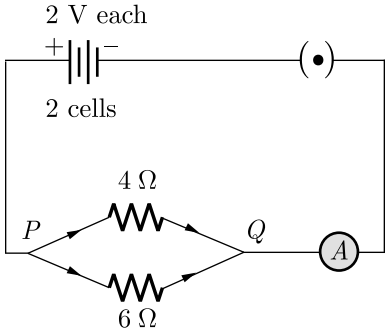
$$= 60 + 60 = 120 \text{ W}$$

436. With reference to the diagram below, calculate:

(i) the equivalent resistance between P and Q

(ii) the reading of the ammeter

(iii) the electrical power between P and Q.



Ans : MAIN 2003

(i) The two resistors, of 4 Ω and 6 Ω are connected in parallel between points P and Q. If R is the equivalent resistance between these two points, then, we have

$$\frac{1}{R} = \frac{1}{4} + \frac{1}{6} = \frac{5}{12}$$

$$= 144 + 1440 = 1584\,\Omega$$

Current in circuit, $I = \dfrac{V}{R_S}$

$$= \frac{120}{1584} = 0.08\,\Omega$$

Same current passes through each bulb.
Power consumed in the bulb A is $P_A = I^2 R_A$
Power consumed in the bulb B is $P_B = I^2 R_B$

Since, $R_A < R_B$

So, $P_A < P_B$

Hence, the bulb B consumes more power than the bulb A, when they are connected in series.

444. Out of the three fuses with current ratings 5 A, 10 A, 15 A, which one is to be connected in a geyser circuit marked 3 KW, 220 V? Give reason for your answer.

Ans : COMP 2018

The current flowing through geyser

$$= \frac{\text{Power}}{\text{Voltage}}$$

$$= \frac{3 \times 1000}{220} = 13.63\text{ A}$$

$$\approx 14\text{ A}$$

The rating of fuse should be just matching with the maximum current carried by the circuit. So the fuse rating should be of 15 ampere.

445. Four lamps of 200 watt, 100 watt, 60 watt and 40 watt are connected to a power supply of 220 volts; calculate :
(i) total current consumed.
(ii) total resistance of this arrangement and
(iii) the cost of keeping them lighted for 7 hours daily for 30 days, the cost of electricity being 30 paise per unit.

Ans : COMP 2021

(i) Total power of the lamps

$$= 200\text{ W} + 100\text{ W} + 60\text{ W} + 40\text{ W}$$

$$= 400\text{ W}$$

$$\text{Current} = \frac{P}{V} = \frac{400}{220} = \frac{20}{11} = 1.8\text{ A}$$

(ii) Resistance of this arrangement :

$$R = \frac{V}{I} = \frac{200}{20} \times 11 = 121\,\Omega$$

(iii) Energy consumed in 30 days for 7 hours daily

$$= \text{Power} \times \text{Time}$$

$$= \frac{400 \times 7 \times 30}{1000}\,\text{KWh}$$

$$= 84\,\text{KWh} = 84\text{ units}$$

Now, total cost

$$= \frac{84 \times 30}{100} = ₹\,25.20$$

446. A 40 W lamp requires 0.182 A of current at 220 V while a 60 W lamp requires 0.272 A of current at 220 V. If a 40 W lamp and a 60 W lamp are connected in series with a 220 V line, how many ampere of current will flow through each lamp?

Ans : SQP 2007

Given, $P_1 = 40\text{ W}$, $I_1 = 0.182\text{ A}$, $V_1 = 220\text{ Volt}$

$P_2 = 60\text{ W}$, $I_2 = 0.272\text{ A}$, $V_2 = 220\text{ Volt}$

Also, $V = 220\text{ Volt}$

Now, $R_1 = \dfrac{V_1^2}{P_1}$

$$= \frac{(220)^2}{40} = 1210\,\Omega$$

and, $R_2 = \dfrac{V_2^2}{P_2}$

$$= \frac{(220)^2}{60} = 806.7\,\Omega$$

When the lamps are connected in series, then the total resistance becomes

$$R_S = R_1 + R_2 = 1210 + 806.7$$

$$= 2016.7\,\Omega$$

Hence, current through the series combination and hence through each lamp.

$$I = \frac{V}{R_S}$$

$$= \frac{220}{2016.7} = 0.109\text{ A}$$

447. Two lamps one rated 100 W, 220 V and the other rated 60 W, 220 V are connected in parallel to a 220 V supply. What current is drawn from the supply line?

Ans : SQP 2011

Given, $P_1 = 100\text{ W}$, 220 Volt

and $P_2 = 60\text{ W}$, 220 Volt

In parallel combination of lamps, the total power consumed is given by

$$P = P_1 + P_2$$

Therefore, we have

$$P = 100 + 60 = 160\text{ W}$$

Since, $P = VI$

Therefore, $I = \dfrac{P}{V} = \dfrac{160}{220} = 0.727\text{ A}$

Click Here to Buy book on Amazon

and their combined resistance is 10 ohm, therefore, we have

$$\frac{1}{10} = \frac{1}{R} + \frac{1}{40},$$

$$R = \frac{10}{3} = 13.3 \text{ ohm}$$

(iii) The current flowing through R is given by

$$I_R = \frac{0.1 \times 40}{40 + 13.3} = 0.3 \text{ A}$$

440. Four resistances of 2.0 Ω each are joined end to end to form a square $ABCD$. Calculate the equivalent resistance of the combination between any two adjacent corners.

Ans : SQP 2005

This situation consists of three resistors connected in series and their combination in parallel with the fourth resistor. Therefore, the equivalent resistance of series combination is given by

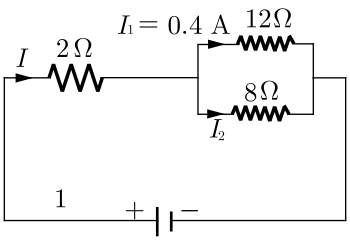
$$R_s = 2 + 2 + 2 = 6 \text{ ohm.}$$

This 6 ohm resistor is connected in parallel to the fourth 2 ohm resistor, therefore, equivalent resistance between any two adjacent corners

$$\frac{1}{R} = \frac{1}{6} + \frac{1}{2} = \frac{2}{3}$$

Therefore, $R = 1.5$ ohm.

441.



In the above circuit diagram, calculate

(i) the external resistance of the circuit

(ii) the current I_2

(iii) the current I

Ans : SQP 2003

(i) External resistance of the circuit,

$$R_S = R_{2\Omega} + (R_{12\Omega} \,||\, R_{8\Omega})$$

$$= R_{2\Omega} + \left(\frac{R_{12\Omega} \times R_{8\Omega}}{R_{12\Omega} + R_{8\Omega}}\right)$$

$$= 2 + \left(\frac{12 \times 8}{20}\right)$$

$$= 2 + 4.8 = 6.8\,\Omega$$

(ii) Voltage across 12 Ω and 8 Ω is equal due to parallel combination.

Voltage across

$$12\,\Omega = I_1 \times R = 12 \times 0.4$$

$$V = 4.8 \text{ V}$$

Current, $I_2 = \frac{V}{R_2} = \frac{4.8}{8}$

$$I_2 = 0.6 \text{ A}$$

(iii) Current, $I = I_1 + I_2$

$$= 0.4 + 0.6 = 1 \text{ A}$$

442. An appliance rated 440 W, 220 V is connected across 220 V supply.

(i) Calculate the maximum current that the appliance can draw.

(ii) Calculate the resistance of the appliance.

Ans : COMP 2010

(i) Given, Power = 440 W

Voltage applied $V = 220$ Volt

$$\text{Current} = \frac{\text{Power}}{\text{Voltage}}$$

$$I = \frac{440}{220} \text{ A} = 2 \text{ A}$$

(ii) Resistance of the appliance,

$$\text{Power} = \frac{V^2}{R}$$

$$R = \frac{V^2}{P} = \frac{220 \times 220}{440}$$

$$= 110\,\Omega$$

443. Two bulbs A and B are rated 100 W, 120 V and 10 W, 120 V respectively. They are connected across a 120 V source in series. Calculate the current through each bulb. Which bulb will consume more power?

Ans : MAIN 2013

According to question,

Resistance of bulb A (Rating 100 W, 120 V) is

$$R_A = \frac{V^2}{P_A}$$

$$= \frac{(120)^2}{100} = 144\,\Omega$$

Resistance of bulb B (rating 10 W, 120 V) is

$$R_B = \frac{V^2}{P_B}$$

$$= \frac{(120)^2}{10} = 1440\,\Omega$$

When they are connected in series across a source of voltage $V = 120$ Volt

Total resistance, $R_S = R_A + R_B$

Downloaded from www.pdf.tube

Dividing equation (1) and (2), we get

$$2 = \frac{8+r}{2+r} \text{ or } 4+2r = 8+r$$

or $r = 4\,\Omega$

Substituting the value of r in (1),

$$0.6 = \frac{E}{2+4} \text{ or } E = 3.6\text{ V}$$

467. A wire of uniform thickness with a resistance of $27\,\Omega$ is cut into three equal pieces and they are joined in parallel. Find the resistance of the parallel combination.

Ans : SQP 2017

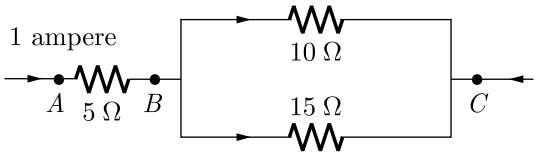
If a wire of resistance $27\,\Omega$ is cut into three equal pieces, the resistance of each piece will be $\frac{27}{3} = 9\,\Omega$.

On joining them in parallel, the resistance of parallel combination (R_{eq}) will be given by

$$\frac{1}{R_{eq}} = \frac{1}{9}+\frac{1}{9}+\frac{1}{9}$$

$$= \frac{3}{9} \text{ or } R_{eq} = 3\,\Omega$$

468. Three resistors are connected as shown in the diagram. A current of 1 ampere flows through the 5 ohm resistor as shown in the diagram.



(i) What is the current through the other two resistors ?

(ii) What is the potential difference across AB and AC ?

(iii) What is the total resistance of the combination?

Ans : COMP 2012

Since 15 Ω and 10 Ω resistances are in parallel

Hence, $\frac{1}{R} = \frac{1}{10}+\frac{1}{15}$

$$= \frac{3+2}{30}$$

$$R = 6\,\Omega$$

Potential difference in parallel = Total current × Resistance only in parallel

$$= 1 \times 6 = 6\text{ volts}$$

Hence, I_1 (Current flowing in 10 Ω resistor)

$$= \frac{V}{R_1} = \frac{6}{10} = 0.6\text{ A}$$

I_2 (Current flowing in 15 Ω resistor)

$$= \frac{V}{R_2}$$

$$= \frac{6}{15} = 0.4\text{ A}$$

Potential difference in wire AB

$$= IR = 1 \times 5 = 5\text{ volts}$$

Total potential difference $= 6+5 = 11$ volts

469. A high resistance voltmeter is connected to a dry cell battery. The voltmeter reads 12 V. When a $24\,\Omega$ resistance is connected across the battery-terminals, the voltmeter reads 7.2 V. Calculate the internal resistance of the battery.

Ans : SQP 2012

Let the internal resistance of the battery be $r\,\Omega$.

Total resistance of the circuit $= (24+r)\,\Omega$

Current through the battery

$$i = \frac{E}{R} = \frac{12}{24+r} \quad \ldots(1)$$

But the current flowing in $24\,\Omega$ resistance

$$i = \frac{7.2\text{ V}}{24\,\Omega} = 0.3\text{ A}$$

From equation (1),

$$0.3\text{ A} = \frac{12\text{ V}}{24+r}$$

$$7.2 + 0.3\,r = 12\text{ V}$$

$$0.3\,r = 16\,\Omega$$

470. An electrical appliance is rated 1500 W, 250 V. This appliance is connected to 250 V mains. Calculate:

(a) the current drawn.

(b) the electrical energy consumed in 60 hours,

(c) the cost of electrical energy consumed at ₹ 2.50 per kWh.

Ans : MAIN 2005

Given, $P = 1500$ W

Operating voltage, $V = 250$ Volt

(a) Current drawn,

$$i = \frac{P}{V} = \frac{1500\text{ W}}{250\text{ V}} = 6\text{ A}$$

(b) Electrical energy consumed in 60 hours

$$= \frac{P \times t}{1000}\text{ kWh}$$

$$= \frac{1500\text{ W} \times 60\text{ h}}{1000}$$

$$= 90\text{ kWh}$$

(c) Cost of electrical energy consumed at ₹ 2.50 per kWh $= 90\text{ KW h} \times ₹\,2.50 = ₹\,225$

NODIA

448. A 25 W and a 100 W bulb are joined in parallel and connected to the A.C. mains. Which bulb will glow brighter?

Ans : SQP 2002

We know that $P = \frac{V^2}{R}$, where V is constant P.D.

Therefore, $\frac{R_{25}}{R_{100}} = \frac{P_{100}}{P_{25}} = \frac{100}{25} = 4$

i.e., the resistance of 25 W bulb is 4 times the resistance of 100 W bulb.

When both bulbs are put in parallel, the potential difference across each of the bulb is the same.

Therefore, ratio of power dissipated is

$$\frac{P'_{25}}{P'_{100}} = \frac{V^2/R_{25}}{V^2/R_{100}} = \frac{R_{100}}{R_{25}} = \frac{1}{4}$$

Therefore, bulb of 100 W will glow four times brighter than the 25 W bulb.

449. A house is fitted with 20 lamps of 60 W each 10 fans consuming 0.5 ampere and one electric kettle of resistance 110 ohm. If the energy is supplied at 220 volt and costs 25 paise per kWh, calculate the monthly bill for running these appliances for 6 hours daily. Take one month = 30 days.

Ans : COMP 2011

Given, Wattage of each lamp = 60 watt

Current through each fan = 0.5 A

Resistance of kettle = 110 ohm

Total wattage of lamps $= 60 \times 20$

$= 1200$ watt

Wattage of one fan $VI = 220 \times 0.5$

$= 110$ watt

Total wattage of 10 fans = 1100 watt

Wattage of electric kettle $= \frac{V^2}{R} = \frac{(220)^2}{110}$

$= 440$ W

Total power consumed $= 1200 + 1100 + 440$

$= 2740$ watt

Total hours $= 30 \times 6 = 180$ hour

Units consumed $= \frac{\text{watt} \times \text{hour}}{1000}$

$= \frac{2740 \times 180}{1000}$

$= 493.2$ unit (KWh)

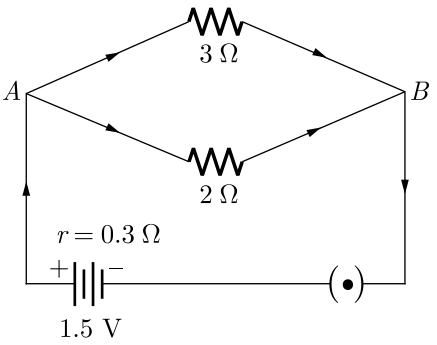
Cost $= 0.25 \times 493.2$

$= ₹\, 123.30$

450. Two resistors of resistance 2 ohm and 3 ohm in parallel are connected to a cell of emf 1.5 V and internal resistance 0.3 ohm. Draw a labelled circuit diagram showing the above arrangement and the current drawn from the cell.

Ans : COMP 2008

The circuit diagram is as shown below



If total resistance between A and B is R, then

$$\frac{1}{R} = \frac{1}{2} + \frac{1}{3} = \frac{5}{6}$$

$$R = 6/5 = 1.2 \text{ ohm}$$

Now, total resistance of the circuit is

$$R_T = R + 0.3$$

$$= 1.2 + 0.3 = 1.5 \text{ ohm}$$

Hence, current in the circuit is

$$I = V/R_T$$

$$= 1.5/1.5 = 1 \text{ A}$$

451. A battery of emf 3 V sends a current of 0.5 A through a wire. Calculate :

(i) the resistance of the wire

(ii) the heat energy produced in one minute.

Ans : MAIN 2003

(i) As we know that,

$$R = V/I$$

$$R = \frac{3}{0.5} = 6\,\Omega$$

(ii) As we know that,

$$H = I^2 Rt$$

$$H = 0.5 \times 0.5 \times 6 \times 60$$

$$H = 90 \text{ J}$$

452. Calculate the resistance between the points X and Y in the network shown below :

Click Here to Buy book on Amazon

Ans : COMP 2016

Given, $P = 24$ W,

$V = 12$ Volt,

$R = ?$

We know that, $P = \frac{V^2}{R}$

$$R = \frac{V^2}{P} = \frac{(12\text{ V})^2}{24\text{ W}}$$

$$= 6\,\Omega$$

If $V = 9$ Volt, $R = 6\,\Omega$, $P = ?$

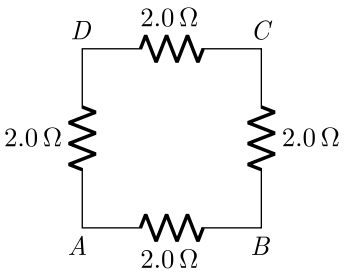
$$P = \frac{V^2}{R}$$

$$= \frac{(9\text{ V})^2}{6\,\Omega} = 13.5\text{ W}$$

461. Four resistances of $2.0\,\Omega$ each are joined end to end to form a square $ABCD$. Calculate the equivalent resistance of the combination between any two adjacent corners.

Ans : SQP 2003

Let the equivalent resistance of the combination between any two adjacent corners be R_{AB}.



$$\frac{1}{R_{AB}} = \frac{1}{2} + \frac{1}{(2+2+2)}$$

$$= \frac{1}{2} + \frac{1}{6}$$

$$\frac{1}{R_{AB}} = \frac{4}{6}$$

$$R_{AB} = 1.5\,\Omega$$

462. Find the cost of operating an electric toaster for two hours if it draws 8 A current on a 110 volt circuit. The cost of electrical energy is ₹ 2.50 per kWh.

Ans : COMP 2003

Given, $V = 110$ Voltage,

$i = 8$ A,

$t = 2$ h

Cost of electrical energy/kWh = ₹ 2.50

Energy consumed in operating an electric toaster

$$= \left(\frac{V \times i \times t}{1000}\right)\text{kWh}$$

$$= \frac{110 \times 8 \times 2}{1000}$$

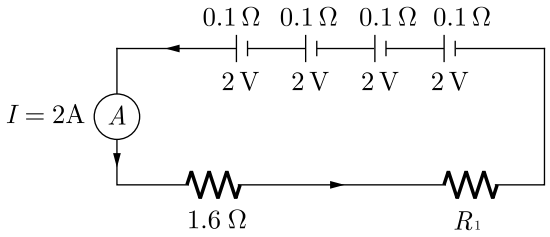
$$= 1.76\text{ kWh}$$

Cost of electrical energy consumed @ ₹ 2.50 per kWh $= 1.76 \times$ ₹ $2.50 =$ ₹ 4.40

463. Four cells each of e.m.f. 2 V and internal resistance $0.1\,\Omega$ are connected in series. The combination is connected in series to an ammeter of negligible resistance, a $1.6\,\Omega$ resistor and an unknown resistor R_1. The current in the circuit is 2 A.
Draw a labelled circuit diagram for the above arrangement and calculate:
(a) The total resistance in the circuit,
(b) The total e.m.f.,
(c) The value of R_1,
(d) The potential difference across R_1.

Ans : MAIN 2019

The labelled diagram is as shown in the figure.



(a) Total resistance $= 1.6 + 0.1 \times 4 + R_1$

$$= 1.6 + 0.4 + R_1$$

$$= (2 + R_1)\,\Omega$$

(b) Total e.m.f. $= 2 + 2 + 2 + 2 = 8$ V

(c) Here, $I = \frac{\text{Total e.m.f.}}{\text{Total resistance}}$

or $2 = \frac{8}{R_1 + 2}$

$$4 + 2R_1 = 8$$

$$2R_1 = 4$$

Hence, $R_1 = 2\,\Omega$

Total resistance $= R_1 + 2$

$$= 2\,\Omega + 2\,\Omega$$

$$= 4\,\Omega$$

(d) Potential difference across

$$R_1 = IR_1$$

$$= 2\text{ A} \times 2\,\Omega = 4\text{ V}$$

NODIA

$P = 1$ W,

$V = 3$ Volt

and $\rho = 1.6 \times 10^{-8}\,\Omega$m

Now, $R = \dfrac{\rho l}{A}$

$= \dfrac{1.6 \times 10^{-8} \times 1}{2 \times 10^{-4}}$

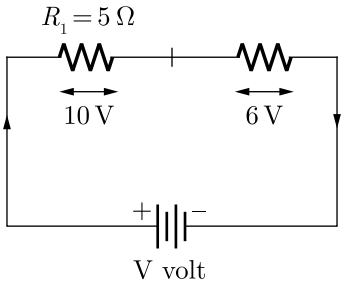
$= 0.8 \times 10^{-4}\,\Omega$

The resistance of the flash light bulb is

$$R = \frac{V^2}{P} = \frac{(3)^2}{1} = 9\,\Omega$$

This shows that the filament has much more resistance than the copper wire.

457. Two resistors are connected in series as shown in the diagram :



(i) What is the current through the 5 ohm resistor ?
(ii) What is the current through R ?
(iii) What is the value of R ?
(iv) What is the value of V ?

Ans : COMP 2021

Potential difference across 5 ohm resistor =10 V
Potential difference across R ohm resistor = 6 V
Value of resistance $R_1 = 5$ ohm
$I = ?$, $R = ?$ and $V = ?$
By Ohm's law, the current through resistor of 5 ohm is

(i) $$I = \frac{V}{R_1} = \frac{10}{5} = 2\text{ A}$$

(ii) Since the two resistors are connected in series, therefore, the current through resistor R is also 2 ampere.
Therefore, value of R can be obtained as follows.

(iii) $$R = \frac{V}{I} = \frac{6}{2} = 3\text{ ohm}$$

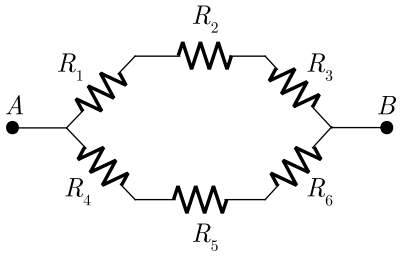
(iv) Since the resistors are in series, therefore, net resistance of the circuit is

$$R_{eq} = R_1 + R = 5 + 3 = 8\,\Omega$$

Hence, by the expression $V = IR$,

We have $V = 2 \times 8 = 16$ V

458. Calculate the equivalent resistance of the circuit as shown in figure, in which six equal resistances of 1 ohm each are connected in hexagonal form.



Ans : MAIN 2021

It can be seen from the figure that R_1, R_2 and R_3 are in series.

Net resistance is $R = R_1 + R_2 + R_3$

$R = 1 + 1 + 1 = 3\,\Omega$

Similarly, R_4, R_5, R_6 are in series, hence net resistance

$$R' = R_4 + R_5 + R_6$$

Hence, $R' = 1 + 1 + 1 = 3\,\Omega$

Now, R and R' are in parallel. Hence, equivalent resistance of the circuit is

$$\frac{1}{R_P} = \frac{1}{R} + \frac{1}{R'}$$

$$= \frac{1}{3} + \frac{1}{3} = \frac{2}{3}$$

Hence, $R_P = \dfrac{3}{2} = 1.5$ ohm

459. Two resistors of 3 ohm and 6 ohm are connected in parallel. What is the equivalent resistance ?

Ans : SQP 2021

Given, $R_1 = 3$ ohm and

$R_2 = 6$ ohm

We know that in parallel combination

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$$

Therefore, we have

$$\frac{1}{R_P} = \frac{1}{3} + \frac{1}{6} = \frac{6+3}{6 \times 3}$$

$$= \frac{9}{18} = \frac{1}{2}$$

Therefore, $R_P = 2$ ohm

460. An electric bulb draws 24 W when connected to a 12 V supply. Find the power if it is connected to a 9 V supply.

Downloaded from www.pdf.tube

$$R = 2.4 \text{ ohm}$$

(ii) The total emf of the two cells is (2 + 2) V = 4V. The equivalent resistance of the circuit is 2.4 Ω. Hence, the ammeter reading, say I, would be given by

$$I = \frac{V}{R} = \frac{4}{2.4} = 1.67 \text{ A}$$

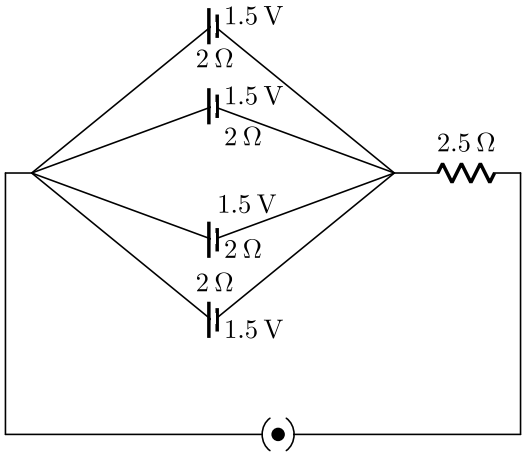
(iii) The electric power, used up between P and Q would be given by

$$P = V^2/R$$
$$= (4)^2/2.4 = 6.67 \text{ watt}$$

437. Four cells each of emf 1.5 V and internal resistance of 2.0 ohm are connected in parallel. The battery of cells is connected to an external resistance of 2.5 ohm. Calculate:
(i) the total resistance of the circuit
(ii) the current flowing in the external circuit and
(iii) the drop in potential across the terminals of the cells.

Ans : COMP 2002

The arrangement of the four cells is as shown in the figure below :



Since all the cells are connected in parallel, therefore, the battery has a net emf of 1.5 V only and its net internal resistance equals, r, where

$$\frac{1}{r} = \frac{1}{2} + \frac{1}{2} + \frac{1}{2} + \frac{1}{2} = 2$$

$$r = 0.5 \text{ ohm}$$

When this battery is connected to an external resistance of 2.5 ohm, the :

(i) Total resistance (R) of the circuit is given by

$$R = 0.5 + 2.5 = 3.0$$

(ii) Current flowing in the external circuit is

$$I = 1.5/R = 1.5/3.0 = 0.5 \text{ A}$$

(iii) For finding the potential drop across the terminals of the cells, we notice that this will equal the D.P. across the external resistance connected to the battery. Hence,Potential drop across the battery

$$V = 0.5 \text{ A} \times 2.5 \Omega = 1.25 \text{ V}$$

438. A family uses a light bulb of 100 W, a fan of 100 W and an electric heater of 1000 W each for 8 hours daily. If the cost of electricity is ₹ 2.00 per unit, what is the expenditure for the family per day on electricity?

Ans : COMP 2001

Given, $P_1 = 100$ W, $P_2 = 100$ W, $P_3 = 1000$ W

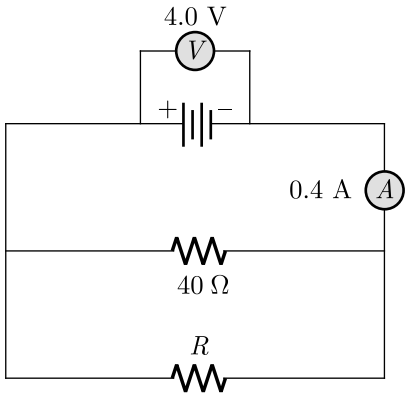
$t = 8$ hours

Cost per kWh = ₹ 2.00

Total electric energy consumed in 8 hours

$$E = P \times t$$
$$= 1200 \times 8 = 9600 \text{ Wh}$$
$$= 9.6 \text{ KWh}$$
$$\text{Cost} = 9.6 \times 2.00 = ₹ 19.20$$

439. In the figure shown below, calculate :
(i) the value of the combined resistances of 40 ohm and R, using the readings of the two metres.
(ii) the value of R and
(iii) the current flowing through R.



Ans : MAIN 2000

Given, $V = 4.0$ Volt and $I = 0.4$ A.

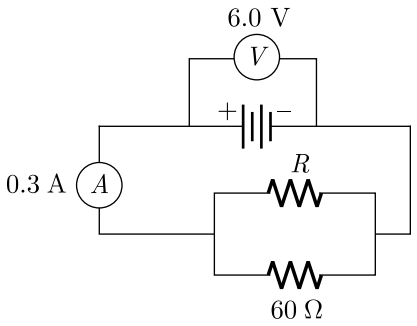
(i) The total resistance of the circuit is

$$R = \frac{V}{I}$$
$$= \frac{4.0}{0.4} = 10 \text{ ohm}$$

(ii) Now, R and 40 ohm are connected in parallel

NODIA

464. In given the figure below, the ammeter A reads 0.3 A.



Calculate:
(a) the total resistance of the circuit.
(b) the value of R.
(c) the current flowing through R.

Ans : MAIN 2022

(a) Given, $i = 0.3\,\text{A}$, $V = 6.0\,\text{Volt}$, $R_{\text{total}} = ?$

$$R_{\text{total}} = \frac{V}{l}$$

$$= \frac{6.0\,\text{V}}{0.3\,\text{A}} = 20\,\Omega$$

(b) Resistance R and $60\,\Omega$ are in parallel combination

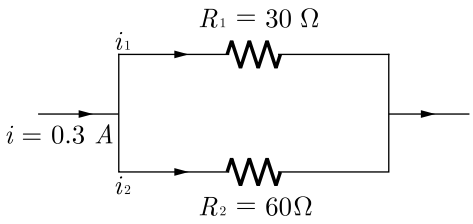
Therefore, $$20\,\Omega = \frac{R \times 60}{R + 60}$$

$$20\,R + 1200 = 60\,R$$

$$40\,R = 1200$$

$$R = \frac{1200}{40} = 30\,\Omega$$

(c) Let the current $i = 0.3\,\text{A}$ be distributed in the two resistors $R_1 = 30\,\Omega$ and $R_2 = 60\,\Omega$ as i_1 and i_2 respectively.



i.e. $$i = i_1 + i_2 \qquad ...(1)$$

The current, $$i_1 = \left(\frac{R_2}{R_1 + R_2}\right) i$$

$$= \left(\frac{60}{30 + 60}\right) \times 0.3$$

$$= \frac{60}{90} \times 0.3$$

$$i_1 = 0.2\,\text{A}$$

From equation (1), the current i_2 in $60\,\Omega$ resistor

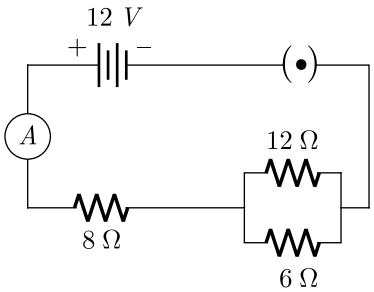
$$= i - i_1$$

$$= 0.3\,\text{A} - 0.2\,\text{A} = 0.1\,\text{A}$$

Note: Here i_2 may also be calculated using

$$i_2 = \left(\frac{R_1}{R_1 + R_2}\right) i$$

465. Three resistors are connected to a 12 V battery as shown in the figure given below:



(a) What is the current though the 8 ohm resistor?
(b) What is the potential difference across the parallel combination of 6 ohm and 12 ohm resistor?
(c) What is the current through the 6 ohm resistor?

Ans : SQP 2014

(a) Total resistance R in circuit $= 8 + R'$

Where, $$\frac{1}{R'} = \frac{1}{12} + \frac{1}{6}$$

$$= \frac{1}{4} \text{ or } R' = 4\,\Omega$$

$$R = 8 + 4 = 12\,\Omega$$

$$I = \frac{12\,\text{V}}{12\,\Omega} = 1\,\text{A}$$

(b) Potential difference across the parallel combination of $6\,\Omega$ and $12\,\Omega$ resistors $= 1\,\text{A} \times 4\,\Omega = 4\,\text{V}$

(c) Current through $6\,\Omega$ resistor $= \frac{4\,\text{V}}{6\,\Omega} = 0.67\,\text{A}$

466. A cell supplies a current of 0.6 A through a $2\,\Omega$ coil and a current of 0.3 A through a $8\,\Omega$ coil. Calculate the e.m.f. and the internal resistance of the cell.

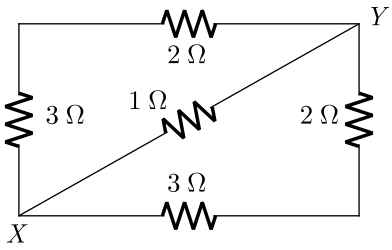
Ans : SQP 2014

Let r be the internal resistance and E be the e.m.f. of the cell, then

$$0.6 = \frac{E}{2 + r} \qquad ...(1)$$

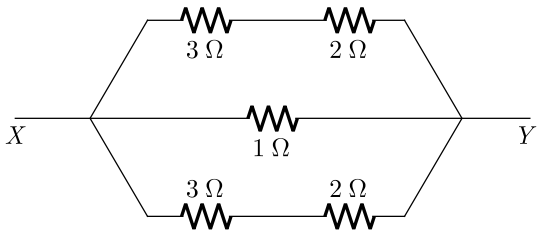
and $$0.3 = \frac{E}{8 + r} \qquad ...(2)$$

Click Here to Buy book on Amazon



Ans : COMP 2007

The equivalent circuit diagram of the above figure can be made as follows :

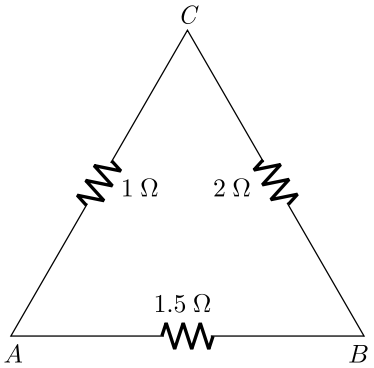


Total resistance is given by

$$\frac{1}{R} = \frac{1}{5} + \frac{1}{1} + \frac{1}{5} = \frac{7}{5}$$

Hence, $R = \frac{5}{7} = 0.71\,\Omega$

453. Calculate the resistance between the points A and B in the network shown below :



Ans : SQP 2007

The resistances 1 Ω and 2 Ω are in series.

The equivalent resistance $= 1 + 2 = 3\,\Omega$

Total resistance is given by

$$\frac{1}{R} = \frac{1}{3} + \frac{1}{1.5}$$

$$\frac{1}{R} = \frac{1+2}{3}$$

$$\frac{1}{R} = \frac{3}{3} = 1\,\Omega$$

Hence, $R = 1\,\Omega$

454. Calculate the resistance of constantan wire 100 cm long and 0.1 cm in diameter when the specific resistance is approximately 40×10^{-8} ohm m.

Ans : SQP 2001

Given, $I = 100\,\text{cm} = 1\,\text{m}$

$$r = 0.05\,\text{cm} = \frac{0.05}{100}\text{m}$$

$$r = 5 \times 10^{-4}\,\text{m}$$

$$\rho = 40 \times 10^{-8}\,\Omega\text{-m}$$

$$R = \rho\frac{l}{a} = \rho\frac{l}{\pi r^2}$$

$$R = \frac{40 \times 10^{-8} \times 1}{22/7 \times (5 \times 10^{-4})^2}$$

$$R = 0.509\,\Omega$$

455. A copper wire has a diameter of 0.5 mm and a resistivity of 1.6×10^{-6} ohm cm. How much of this wire would be necessary to make a resistance of 10 ohm?

Ans : SQP 20015

Given, $d = 0.5\,\text{mm}$

Hence,Radius $r = \frac{d}{2}$

$$= 0.25\,\text{mm} = 0.025\,\text{cm}$$

$$\rho = 1.6 \times 10^{-6}\,\Omega\,\text{cm}$$

$$R = 10\,\text{ohm}$$

We know that, $R = \frac{\rho l}{A}$

Therefore, we have

$$l = \frac{RA}{\rho} = \frac{R\pi r^2}{\rho}$$

$$= 10 \times \frac{22}{7} \times \frac{(0.025)^2}{1.6 \times 10^{-6}}$$

$$= 12276.7\,\text{cm or } 122.77\,\text{m}$$

456. Calculate the resistance of 1 metre of copper wire that has a cross-sectional area of about 2 cm^2, where the value of resistivity of copper is

$$\rho = 1.6 \times 10^{-8}\,\Omega\text{m}$$

Compare the value of this resistance with that of a flash light bulb which has a power rating of 1 W and operates at 3 V. What does this comparison tell you?

Ans : SQP 2015

Given, $L = 1\text{ m}$,

$$A = 2\text{ cm}^2 = 2 \times 10^{-4}\,\text{m}^2,$$

NODIA

471. A house is fitted with 20 bulbs rated 100 W each, 10 fans running at 0.5 A current and an electric kettle of 100 Ω resistance. Electricity is supplied at 220 V and at a rate of ₹ 3.20 per kW h. What will be the expenditure of electricity in the month of August, if all the appliances are used for 6 hours daily?

Ans : MAIN 2005

Given,

Number of bulbs $n_{\text{bulb}} = 20$; $P_{\text{bulb}} = 100$ W;

$$V = 220 \text{ V}$$

Number of fans $n_{\text{fan}} = 10$; $i_{\text{fan}} = 0.5$ A; $t = 6$ h

Total energy consumed by the appliance in a day

= Power of (20 bulbs + 10 fans + one kettle) × time

$$= \left[20 \times 100 \text{ W} + 10 \times 220 \text{ V} \times 0.5 \text{ A} + \frac{(200 \text{ V})^2}{100 \Omega}\right] \times 6 \text{ h}$$

$$= (2000 \text{ W} + 1100 \text{ W} + 484 \text{ W}) \times 6 \text{ h}$$

$$= 21504 \text{ W h}$$

$$= 21.504 \text{ KW h}$$

Number of units consumed in 31 days

$$= 21.504 \text{ KW h} \times 31 \text{ d}$$

$$= 666.624 \text{ KW h}$$

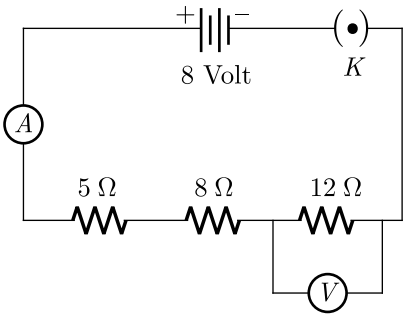
The cost of electricity consumed in the month of August

$$= 666.624 \text{ KW h} \times ₹ 3.20$$

$$= ₹ 2133.20$$

472. Redraw the circuit of the previous question, putting in an ammeter to measure the current through the resistors and a voltmeter to measures the voltage across the 12 ohm resistor. What is the reading of the ammeter and the voltmeter ?

Ans : COMP 2021



Since the resistors are connected in series, therefore, the equivalent resistance of the combination is

$$R_S = R_1 + R_2 + R_3$$

$$= 5 + 8 + 12 = 25 \Omega$$

Now, current in the circuit

$$I = \frac{V}{R_S} = \frac{8}{25} = 0.32 \text{ A}$$

Voltage across the 12 ohm resistor

$$V = IR$$

$$= 0.32 \times 12 = 3.84 \text{ V}$$

473. A house is fitted with a motor of one horse power, 5 bulbs consuming 0.2 A each and two fans of 80 W each. If all the appliances work for five hours daily, calculate the monthly bill. Energy costs 20 paise per unit. The energy is supplied at 220 V. Given 1 hp = 746 W.

Ans : MAIN 2021

Given, Power of motor 1 hp = 746 W

Power of one bulb, $P = V \times I$

$$= 220 \times 0.2 = 44 \text{ W}$$

Therefore, power of 5 bulbs = $5 \times 44 = 220$ W

Power of two fans = $2 \times 80 = 160$ W

Total power of all electrical appliances

$$= 746 + 220 + 160$$

$$= 1126 \text{ W}$$

Since all appliances work for 5 hours daily, therefore, Energy consumed in one day

$$= 1126 \times 5 \text{ watt hour}$$

$$= 5630 \text{ watt hour}$$

Energy consumed in one month

$$= 30 \times 5630 \text{ watt hour}$$

or Units consumed = $\frac{30 \times 5630}{1000}$

$$= 168.9 \text{ kWh}$$

Hence, Cost of energy = 0.20×168.9

$$= ₹ 33.78$$

474. Calculate the resistance of the filament of the bulb when it is glowing and the current which can flow through a bulb of rating 60 W-220 V.

Ans : SQP 2009

We know that,

$$\text{Power} = 60 \text{ W}$$

$$V = 220 \text{ Volt}$$

$$P = \frac{V^2}{R}$$

NODIA

$$R = \frac{V^2}{P}$$

$$= \frac{(220)^2}{60} = 806.7\ \Omega$$

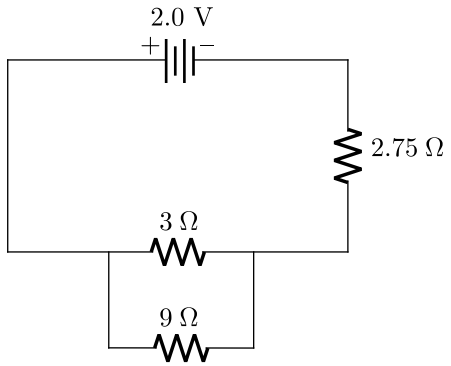
We know that,

$$P = VI$$

$$I = \frac{P}{V}$$

$$I = \frac{60}{220} = 0.27\ \text{amp.}$$

475. A cell of 2.0 volt and negligible resistance is connected in an electrical circuit as shown in the figure.



Calculate the current flowing through each resistance and through the cell.

Ans : SQP 2016

In the given circuit $3\,\Omega$ and $9\,\Omega$ resistances are connected in parallel combination. Therefore

$$\frac{1}{R_p} = \frac{1}{3} + \frac{1}{9}$$

Hence, $$R_p = \frac{9}{4} = 2.25\,\Omega$$

Total resistance in circuit

$$= 2.25 + 2.75 = 5.0\,\Omega$$

Current passing through the circuit

$$I = \frac{V}{R}$$

$$= \frac{2}{5} = 0.4\ \text{A}$$

P.D. across the resistors in parallel

$$= 0.4 \times 2.25 = 0.9\ \text{V}$$

P.D. across the $2.75\,\Omega$ resistor

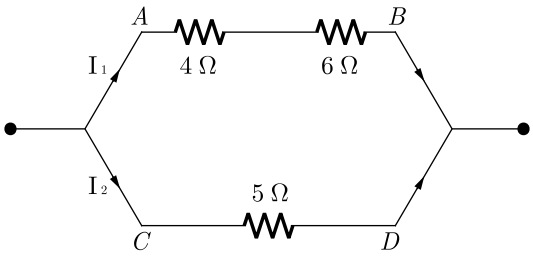
$$= 0.4 \times 2.75 = 1.1\ \text{V}$$

Current passing through the $9\,\Omega$ resistor

$$= 0.9/9 = 0.1\ \text{A}$$

Current in series remains same i.e., equal to total current $= 2.75\,\Omega$ resistor $= 0.4$ A.

476. In the circuit below, the heat produced in the 5 ohm resistor due to current flowing through it is 10 calorie per second. Find the heat produced in the 4 ohm resistor.



Ans : COMP 2010

Let I_1 and I_2 be the currents flowing through the arms AB and CD respectively, then

As in parallel P.D. remains same and I_1 and I_2 are inversely proportional to their resistances (total).

$$\frac{I_1}{I_2} = \frac{5}{10} = \frac{1}{2} \qquad \ldots(1)$$

Let H_1 and H_2 be the amounts of heat produced in the 4 ohm and 5 ohm resistor respectively in a certain time. Then,

$$\frac{H_1}{H_2} = \frac{I_1^2 \times 4 \times t}{I_2^2 \times 5 \times t}$$

$$= \left(\frac{I_1}{I_2}\right)^2 \times \frac{4}{5} \qquad \ldots(2)$$

Substituting equation (1) in equation (2), we have

$$\frac{H_1}{H_2} = \left(\frac{I_1}{I_2}\right)^2 \times \frac{4}{5}$$

$$= \left(\frac{1}{2}\right)^2 \times \frac{4}{5} = \frac{1}{5}$$

Since $H_2 = 10$ calorie, therefore, we have

$$H_1 = H_2 \times \frac{1}{5}$$

$$= 10 \times \frac{1}{5} = 2\ \text{calorie}$$

477. An electric heater is rated 500 KVA, 220 V. If the heater is operated for 1 hour, calculate the energy consumed (i) in kWh and (ii) in joule.

Ans : SQP 2009

Given, $P = 500\ \text{KVA} = 500\ \text{KW}$ $(VA = W)$

$$VI = P$$

The energy consumed in 1 hour is

$$E = 500\ \text{kW} \times 1\ \text{hour} = 500\ \text{kWh}$$

Now, $1\ \text{kWh} = 3.6 \times 10^6\ \text{J}$

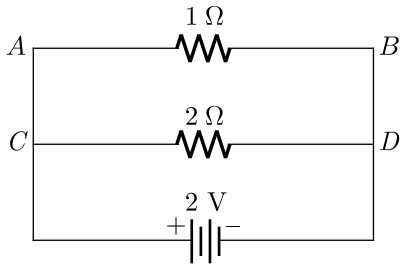
Energy consumed in joule

$$= 500 \times 3.6 \times 10^6\ \text{J}$$

$$= 1.8 \times 10^9\ \text{J}$$

Downloaded from www.pdf.tube

478. What is the current through each of resistances in the circuit ?



Ans : COMP 2003

Let R be the total resistance of the given circuit.

$$\frac{1}{R} = \frac{1}{1} + \frac{1}{2} = \frac{2+1}{2} = \frac{3}{2}$$

$$R = \frac{2}{3}\,\Omega$$

$$\text{Total current } I = \frac{2}{2} = \frac{2 \times 3}{2} = 3\text{ A}$$

Current through AB: $I_1 = \dfrac{V}{R_1} = \dfrac{2}{1}$

$= 2$ ampere

Current through CD: $I_2 = \dfrac{V}{R_2} = \dfrac{2}{2}$

$= 1$ ampere

479. An electric bulb rated 220 V, 60 W glows when connected with 220 V mains.

(i) Find the resistance of the filament of the bulb.

(ii) Another identical bulb is connected in series with the first one and the system is connected across the 220 V mains. Draw a diagram to show the arrangement and find:

(a) the rate of conversion of energy in each bulb, and

(b) total power consumed.

(iii) If two bulbs are connected in parallel, draw a diagram of this arrangement. What will be the total power then consumed?

Ans : COMP 2020

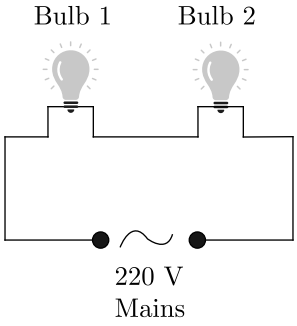
Given; Rating of bulb 220 V, 60 W i.e., voltage $V = 220$ volt and power $P = 60$ watt.

(i) Resistance of filament of the bulb

$$R = \frac{V^2}{P}$$

$$= \frac{(220)^2}{60} = 806.67\,\Omega$$

(ii) The arrangement of two identical bulbs in series with the mains is shown in fig. In this arrangement, voltage across each bulb will be $V = 110$ volt.



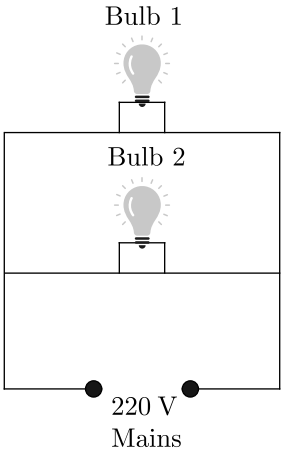
(a) Rate of conversion of energy in each bulb

$$= \frac{V^2}{R} = \frac{(110)^2}{806.67} = 15\text{ W}$$

(b) Total power consumed in the two bulbs

$$= 15 + 15 = 30\text{ W}$$

(iii) The arrangement of two identical bulbs in parallel with the mains is shown in fig. In this arrangement, voltage across each bulb will be $V = 220$ volt and then power spent in each bulb will be 60 W.



So, total power consumed in the two bulb

$$= 60 + 60 = 120\text{ W}$$

480. The following circuit diagram shows three resistors 2 ohm, 4 ohm and R ohm connected to a battery of emf 2 V and internal resistance 3 ohm. A main current of 0.25 A flows through the circuit.

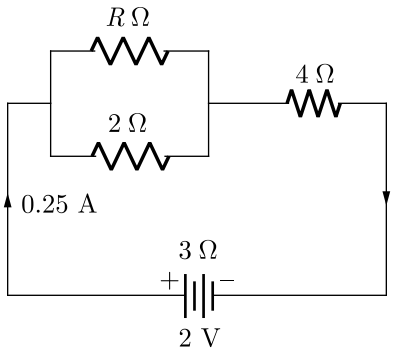
(a) What is the potential difference across the 4 ohm resistor?

(b) Calculate the potential difference across the internal resistance of the cell.

(c) What is the potential difference across R and 2 ohm resistors?

(d) Calculate the value of R.

NODIA



Ans : SQP 2020

(a) Potential difference across 4 Ω

$$= 0.25 \times 4 = 1.0\,\text{V}$$

(b) Potential difference across the internal resistance of cell

$$= 3 \times 0.25 = 0.75\,\text{V}$$

(c) Potential difference across R or the 2 Ω resistor

$$= (2 - 1.75) = 0.25\,\text{V}$$

(d) $0.25 = 0.25 \times$ Combined resistance

Hence R (Combined resistance) $= 1\,\Omega$

$$\frac{1}{2} + \frac{1}{R} = 1$$

$$R = 2\,\Omega$$

481. Calculate the number of electrons passing per second through a conductor to give a current of 1 A. Charge on an electron $= 1.6 \times 10^{-19}$ C.

Ans : COMP 2003

Let n be the number of electrons passing per sec. when 1 ampere of current is passed, then total charge per second $= ne$

As we know that,

$$I = \frac{ne}{T}$$

$$n = \frac{I}{e} \qquad (T = 1\,\text{s})$$

$$n = \frac{1 \times 1}{1.6 \times 10^{-19}}$$

$$= 6.25 \times 10^{18} \text{ electrons}$$

482. A piece of wire is redrawn by pulling it until its length is doubled. Compare the new resistance with the original resistance.

Ans : MAIN 2002

Let

L - length of the wire before stretching

L' - length of the wire after stretching

r - radius of the wire before stretching

r' - radius of the wire after stretching

Then,

$$R = \frac{\rho L}{\pi r^2} \text{ and } R' = \frac{\rho L'}{\pi r'^2}$$

Since the volume of the wire remains constant Therefore, we have

$\pi r^2 L = \pi r'^2 L' = \pi r'^2 nL$ or we have $r^2 = nr'^2$

Therefore, $$\frac{R'}{R} = \frac{L' r^2}{L r'^2} = n.n = n^2$$

Therefore, we have

$$R' = n^2 R$$

Here, $$n = 2$$

$$R' = 4R$$

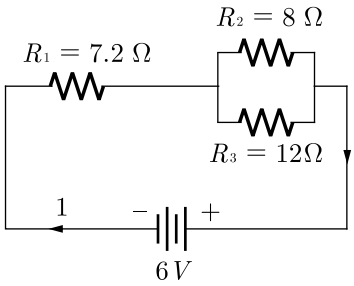
The resistance of the stretched wire will be four times that of the original wire.

483. In the given circuit, calculate :

(i) equivalent resistance of the circuit.

(ii) total current in the circuit.

(iii) potential difference across each resistor.



Ans : SQP 2014

(i) From the figure, it can be seen that R_2 and R_3 are in parallel, therefore, the total resistance is

$$\frac{1}{R_P} = \frac{1}{R_2} + \frac{1}{R_3}$$

$$= \frac{1}{8} + \frac{1}{12} = \frac{5}{24}$$

$$R_P = 4.8 \text{ ohm}$$

Also, R_1 and R_P are in series.

Hence, Equivalent resistance of the circuit R' will be

$$R' = R_P + R_1$$

$$= 4.8 + 7.2 = 12 \text{ ohm}$$

(ii) The potential difference in the circuit is 6 V. Let the current in the circuit be I and the equivalent resistance is 12 Ω, then from $V = IR$

$$6 = 1 \times 12$$

Click Here to Buy book on Amazon

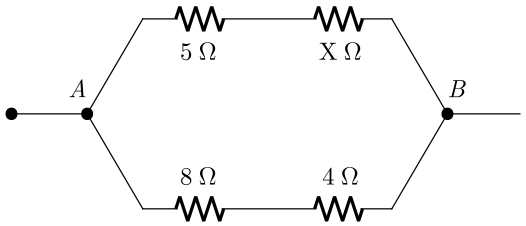
$$I = 0.5\ A$$

(iii) Since $R_1 = 7.2\,\Omega$ and $I = 0.5\,A$, hence, potential difference across R_1 is

$$V_1 = IR_1$$
$$= 0.5 \times 7.2 = 3.6 \text{ volt}$$

Also, the potential difference of 6 V − 3.6 V = 2.4 V is maintained across the parallel combination of R_2 and R_3. Hence, potential difference across $R_2 = 2.4$ V and across $R_3 = 2.4$ V (since they are in parallel).

484. The equivalent resistance of the following circuit diagram is $4\,\Omega$. Calculate the value of x.



Ans : SPQ 2014

In the above diagram the resistors are connected in the series ,therefore the equivalent resistance is given by,

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$
$$\frac{1}{4} = \frac{1}{5+x} + \frac{1}{8+4}$$
$$= \frac{1}{5+x} + \frac{1}{12}$$
$$= \frac{12+5+x}{12\,(5+x)}$$

Hence, $x = 1\,\Omega$

485. An electric heater is rated 1000 W - 200 V. Calculate:
(i) the resistance of the heating element.
(ii) the current flowing through it.

Ans : COMP 2017

(i) Power, $P = \frac{V^2}{P}$

The resistance of the heating element,

$$R = \frac{V^2}{P}$$
$$= \frac{(200\text{ V})^2}{1000\text{ W}} = 40\,\Omega$$

(ii) The current flowing through the resistance,

$$i = \frac{P}{V}$$
$$= \frac{1000\text{ W}}{200\text{ V}} = 5\text{ A}$$

486. If 3.2×10^{17} electrons pass through a wire in 1/120 min., calculate the current passing through the wire. Charge on an electron is 1.6×10^{-19} C.

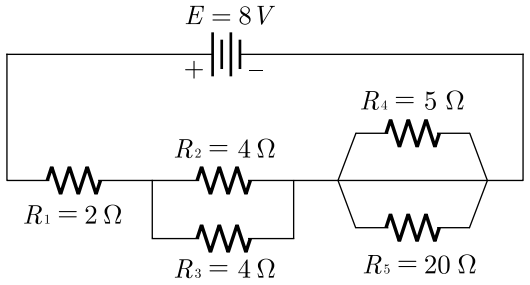
Ans : SQP 2000

$$n = 3.2 \times 10^{17},$$
$$t = \frac{1}{120}\text{min}$$
$$= \frac{1}{120} \times 60\text{ s} = 0.5\text{ s},$$
$$e = 1.6 \times 10^{-19}\text{ C},\ i = ?$$

We know that,

$$i = \frac{q}{t} = \frac{ne}{t}$$
$$= \frac{3.2 \times 10^{17} \times 1.6 \times 10^{-19}\text{ C}}{0.5\text{ s}}$$
$$= 0.102\text{ A}$$

487. Find the current flowing in the circuit shown in the figure.



Ans : COMP 2000

Total resistance R in the circuit $= R_1 + R'$ of parallel combination of R_2 and $R_3 + R''$ of parallel combination of R_4 and R_5

R' is given by $\frac{1}{R'} = \frac{1}{R_2} + \frac{1}{R_3}$

$$= \frac{1}{4} + \frac{1}{4} = \frac{1}{2}$$
$$R' = 2\,\Omega$$

R'' is given by $\frac{1}{R''} = \frac{1}{R_4} + \frac{1}{R_5}$

$$= \frac{1}{5} + \frac{1}{20} = \frac{1}{4}$$
$$R'' = 4\,\Omega$$
$$R = R_1 + R' + R''$$
$$= 2\,\Omega + 2\,\Omega + 4\,\Omega = 8\,\Omega$$

Current flowing in the circuit,

NODIA

$$i = \frac{V}{R} = \frac{8\text{ V}}{8\,\Omega} = 1\text{ A}$$

488. Calculate the value of the resistance which must be connected to a $15\,\Omega$ resistance to provide an effective resistance of $6\,\Omega$.

Ans : COMP 2000

Let R resistance is connected with $15\,\Omega$ resistance in parallel to obtain equivalent resistance of $6\,\Omega$ i.e. in parallel combination equivalent resistance

$$R = \frac{R_1 R_2}{R_1 + R_2}$$

$$6 = \frac{15 \times R}{15 + R}$$

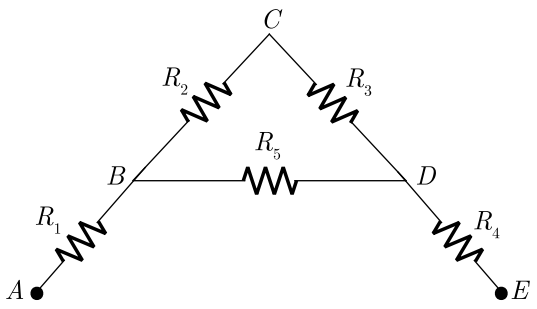
$$15 + R = \frac{15R}{6}$$

Hence, $15 + R = 2.5R$

$$1.5\,R = 15$$

$$R = \frac{15}{15} = 10\,\Omega$$

489. A letter A consists of a uniform wire of resistance 1 ohm per cm, the sides of the letter are each 20 cm long and the cross piece in the middle is 10 cm long. Find the resistance of the letter between points (i) BD and (ii) AB.



Ans : MAIN 2017

Clearly, $CD = DB = CB = 10\text{ cm}$

As $AC = CE = 20\text{ cm}$

Hence, $AB = DE = \frac{1}{2}AC = 10\text{ cm}$

Clearly, $AB = BC = CD = DE$

$$= BD = 10\text{ cm}$$

Therefore, $R_1 = R_2 = R_3 = R_4 = R_5 = 10\,\Omega$

As R_2 and R_3 are in series, therefore, their combined resistance is $10 + 10 = 20$ ohm.

This combination is in parallel with R_5.

(i) Resistance between points B and D is

$$\frac{1}{R} = \frac{1}{20} + \frac{1}{10} = \frac{3}{20}$$

or $$R = \frac{20}{3} = 6.67\,\Omega$$

(ii) Now, resistance R_1, R and R_4 are in series, therefore, resistance across AB is

$$R' = R + R_1 + R_4$$

$$= 6.67 + 10 + 10$$

$$= 26.67\,\Omega$$

490. The resistances of a wire of length 60 cm and of uniform area of cross-section 0.015 cm^2, is found to be 0.75 Ω. Calculate the specific resistance of the wire.

Ans : COMP 2017

Given, $I = 60\text{ cm}$

$$A = 0.015\text{ cm}^2$$

$$R = 0.75\,\Omega$$

We know that $R = \rho l/A$

Hence, $\rho = RA/l$

$$\rho = \frac{0.75 \times 0.015}{60}$$

$$\rho = 1.875 \times 10^{-4}\,\Omega\text{ cm}$$

491. A battery of 6 V, having a negligible internal resistance is connected to four resistors of magnitude 5 Ω, 4 Ω, 3 Ω and $x\,\Omega$ in series. If the current flowing in the circuit is 0.4 A, calculate the unknown resistance.

Ans : SQP 2006

Total resistance in series $= 5 + 4 + 3 + x$

$$= 12 + x$$

$$V = IR$$

Hence, $I = V/R = \frac{6}{12 + x}$

$$(0.4)(12 + x) = 6$$

$$4.8 + 0.4x = 6$$

$$0.4x = 6 - 4.8 = 1.2$$

$$x = \frac{1.2}{0.4} = 3$$

Hence, $x = 3\,\Omega$

492. A current of 2 ampere passes through a conductor and produces 80 J of heat in 10 seconds. Find the resistance of the conductor.

Ans : SQP 2009

Given, $I = 2\text{ A}$, $H = 80\text{ J}$, $t = 10\text{ s}$, $R = ?$

Downloaded from www.pdf.tube

We know that, $H = I^2Rt$, therefore, we have

$$R = \frac{H}{I^2 t}$$

$$= \frac{80}{(2)^2 \times 10} = 2 \text{ ohm}$$

493. A current of 4 A flows through a 12 V car head light bulb for 10 minutes. How much energy transfer takes place during this time?

Ans : COMP 2022

Given, $I = 4\,\text{A}$, $V = 12\,\text{Volt}$

and $t = 10\,\text{min} = 600\,\text{s}$

$$\text{Total energy consumed} = V \times I \times t$$

$$= 12 \times 4 \times 600$$

$$= 28800\,\text{J} = 28.8\,\text{KJ}$$

494. Two bulbs are marked 60 W, 220 V and 60 W, 110 V respectively. Calculate the ratio of their resistances.

Ans : MAIN 2020

Here, $P_1 = 60\,\text{W}$, $V_1 = 220\,\text{Volt}$

and $P_2 = 60\,\text{W}$, $V_2 = 110\,\text{Volt}$

From $R = \frac{V^2}{P}$

$$\frac{R_1}{R_2} = \left(\frac{V_1^2}{V_2^2}\right) \times \left(\frac{P_2}{P_1}\right)$$

Where, R_1 and R_2 are the resistances of both the lamps respectively.

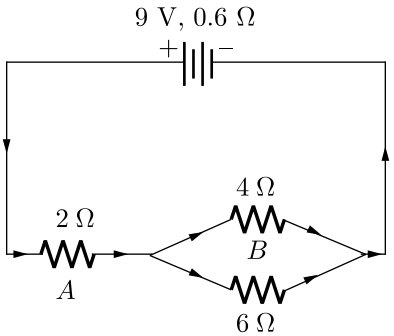
$$\frac{R_1}{R_2} = \left(\frac{220}{110}\right)^2 \times \left(\frac{60}{60}\right)$$

$$\frac{R_1}{R_2} = 4$$

$$R_1 = 4R_2$$

$R_1 : R_2 :: 4 : 1$

495. The diagram below shows a battery of emf 9 V and internal resistance 0.6 ohm connected to three resistors A, B and C.



(i) Calculate the combined resistance B and C.
(ii) Calculate the total resistance of A, B and C.
(iii) Calculate the total resistance of the circuit.
(iv) Calculate the current in each of the three resistors A, B and C.

Ans : MAIN 2020

(i) Let R be the combined resistance of B and C which are connected in parallel, then we have

$$\frac{1}{R} = \frac{1}{4} + \frac{1}{6}$$

$$= \frac{5}{12} \text{ or } R = 2.4 \text{ ohm}$$

(ii) Now, R and A are connected in series, therefore, the total resistance, say Y, of A, B and C is given by $Y = A + R = (2 + 24)$ $= 4.4$ ohm.

(iii) The total resistance, say Z, of the circuit, is given by

$$Z = (Y + 0.6)\,\Omega$$

$$= (4.4 + 0.6)\,\Omega = 5.0\,\Omega$$

(iv) The current flowing in the circuit is

$$I = 9/Z = 9/5 = 1.8\,\text{A}$$

This is also the current through the resistor A.

Thus, $I_A = 1.8\,\text{A}$

Now, current through B and C is obtained by using the formula,

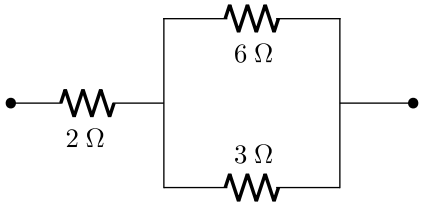
$$I_C = \frac{IR_B}{R_B + R_C}$$

$$= \frac{1.8 \times 4}{4 + 6} = 0.72\,\text{A} \text{ and}$$

$$I_B = \frac{IR_C}{R_B + R_C}$$

$$= \frac{1.8 \times 6}{4 + 6} = 1.08\,\text{A}$$

496. Calculate the equivalent resistance of the combination shown in figure



Ans : SQP 2013

Resistors 6 ohm and 3 ohm are in parallel. Therefore, we have

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$$

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!

Hence, $$\frac{1}{R_P} = \frac{1}{3} + \frac{1}{6} = \frac{6+3}{6\times 3}$$
$$= \frac{9}{18} = \frac{1}{2}$$
$$R_P = 2\,\Omega$$

Now, 2 ohm and R_P are in series
$$R = R_1 + R_P$$
$$= 2 + 2 = 4\,\Omega$$

Hence, the equivalent resistance of the circuit is 4 ohm.

497. Two cells having an emf of 2 V and an internal resistance of 1.5 Ω each are connected in parallel. The arrangement is then connected to a 4.25 Ω resistor. Calculate the current flowing in 4.25 Ω resistor.

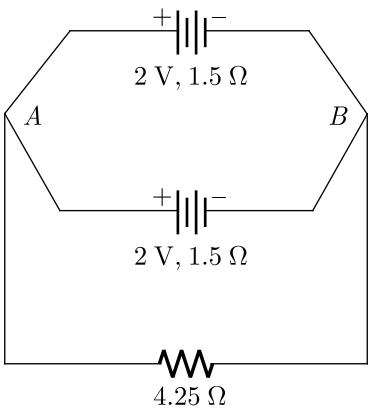
Ans : COMP 2013

Total internal resistance is
$$\frac{1}{r} = \frac{1}{1.5} + \frac{1}{1.5} = \frac{2}{1.5}\,\Omega$$
$$r = \frac{1.5}{2} = 0.75\,\Omega$$

emf of one cell = emf of all the cells in parallel

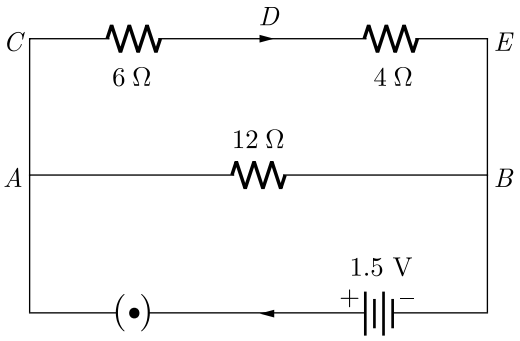
Hence, $E = 2$ V

Total resistance in the circuit
$$= r + R$$
$$= (0.75 + 4.25)\,\Omega = 5\,\Omega$$



Now, $$I = \frac{E}{R+r}$$
$$I = \frac{2}{5} = 0.4\,\text{A}$$

498. In the circuit shown in figure, calculate
(i) the current through the arms AB, AC and CDE
(ii) the potential difference across AB, CD and DE



Ans : MAIN 2019

Resistors of 6 ohm and 4 ohm are in series, therefore, equivalent resistance of the combination
$$R_S = 6 + 4 = 10\,\text{ohm}$$

Now, this 10 ohm resistance and the 12 ohm resistance are in parallel, therefore, equivalent resistance of the circuit is
$$R_P = \frac{10\times 12}{10+12}$$
$$= \frac{120}{22} = 5.45\,\text{ohm}$$

Now, current in the circuit
$$I = \frac{V}{R_P}$$
$$= \frac{1.5}{120}\times 22 = 0.275\,\text{A}$$

(i) Let I_1 be the current through arm AB and I_2 be the current through arm AC and CDE. Then current through arm AB is
$$I_1 = \frac{IR_S}{12+R_S}$$
$$= \frac{0.275\times 10}{12+10}$$
$$= \frac{2.75}{22} = 0.125\,\text{A}$$

Hence, current through arm AC and CDE is
$$I_2 = I - I_1$$
$$= 0.275 - 0.125$$
$$= 0.150\,\text{A}$$

(ii) Since AB is connected to the cells of potential 1.5 V, therefore,
Potential difference across AB will also be 1.5 V.
Potential difference across CD is
$$V = I_2 \times 6$$
$$= 0.150\times 6 = 0.9\,\text{V}$$

Potential difference across DE is
$$V = I_2 \times 4$$
$$= 0.150\times 4 = 0.6\,\text{V}$$

Click Here to Buy book on Amazon

499. A bulb is joined to a battery of e.m.f. 6 V. A steady current of 0.5 A flows through the circuit. Calculate the total energy provided by the battery in 5 minutes.

Ans : SQP 2021

Given, e.m.f. of battery, $E = 6$ Volt

Current flows, $i = 0.5$ A,

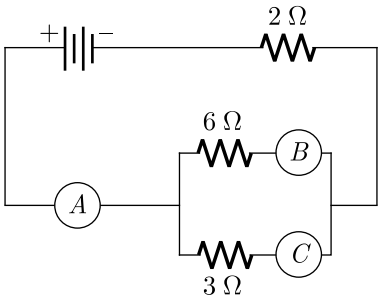
Time, $t = 5$ min $= 300$ seconds

Energy provided by the battery

= e.m.f. of battery × current flowing × time

$= E \times i \times t = 6\,\text{V} \times 0.5\,\text{A} \times 300\,\text{s} = 900\,\text{J}$

500. In the given figure A, B and C are three ammeters. The ammeter B reads 0.5 A.
(All the ammeters have negligible resistance.)



Calculate:
(a) the readings in the ammeters A and C.
(b) the total resistance of the circuit.

Ans : MAIN 2018

(a) As 6 Ω and 3 Ω resistances are in parallel, The potential difference across these resistances will be same, i.e.

$$i_B \times 6\,\Omega = i_C \times 3\Omega$$

$$0.5\,\text{A} \times 6\,\Omega = i_C \times 3\,\Omega$$

$$i_C = 1.0\,\text{A}$$

The reading of ammeter $C = 1.0$ A
The reading of ammeter A will be equal to the sum of the readings of ammeter B and ammeter C i.e.,

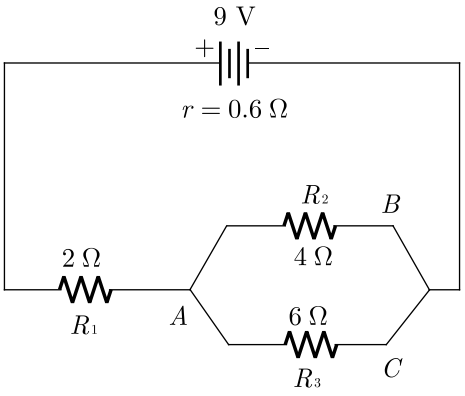
$$= 0.5\,\text{A} + 1.0\,\text{A} = 1.5\,\text{A}$$

(b) Total resistance of the circuit

$$= 2\,\Omega + \frac{6\Omega \times 3\Omega}{6\Omega + 3\Omega}$$

$$= 2\,\Omega + 2\,\Omega = 4\,\Omega$$

501. The figure below shows a battery having an e.m.f. of 9 V and internal resistance $r = 0.6\,\Omega$, connected to three resistors A, B and C. Calculate the current in each resistor.



Ans : COMP 2016

Total resistance is given by

$$R = R_1 + \frac{R_2 R_3}{R_2 + R_3}$$

$$= 2 + \frac{4 \times 6}{4 + 6} = 4.4\,\Omega$$

Now, $\text{current} = \dfrac{9\,\text{V}}{(4.4 + 0.6)\,\Omega} = 1.8\,\text{A}$

Current through $A = 1.8$ A

Current through $B = I\left(\dfrac{R_3}{R_2 + R_3}\right)$

$$= 1.8\left(\frac{6}{6+4}\right)$$

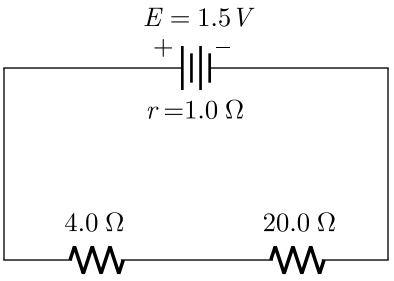
$$= 1.08\,\text{A}$$

Current through $C = I\left(\dfrac{R_2}{R_2 + R_3}\right)$

$$= 1.8\left(\frac{4}{4+6}\right)$$

$$= 1.8\left(\frac{4}{10}\right) = 0.72\,\text{A}$$

502. A cell of e.m.f. 1.5 V and internal resistance 1.0 Ω is connected to two resistors of 4.0 Ω and 20.0 Ω in series as shown in the figure:



Calculate the:
(a) current in the circuit.
(b) potential difference across the 4.0 ohm resistor.

Downloaded from www.pdf.tube

(c) voltage drop when the current is flowing.
(d) potential difference across the cell.

Ans : COMP 2016

(a) Current in the circuit,

$$i = \frac{E}{R_s + r}$$
$$= \frac{1.5}{(4.0 + 20.0) + 1.0}$$
$$= \frac{1.5}{25} = 0.06 \text{ A}$$

(b) Potential difference across $4.0\,\Omega$ resistor
$$= 0.06 \text{ A} \times 4.0\,\Omega = 0.24 \text{ V}$$

(c) Voltage drop when the current is flowing,
$$ir = 0.06 \text{ A} \times 1.0\,\Omega = 0.06 \text{ V}$$

(d) Potential difference across the cell
$$= E - ir$$
$$= 1.5 \text{ V} - 0.06 \text{ V}$$
$$= 1.44 \text{ V}$$

503. The potential difference between the terminals of a cell in an open circuit was 2.2 V and when it was connected through a resistance of 5 ohm, the potential difference fell to 1.8V. Find the internal resistance of the cell.

Ans : MAIN 2012

Given, $E = 2.2$ V,
$R = 5$ ohm,
V = 1.8 Volt and
$r = ?$

The expression for internal resistance is
$$r = \frac{(E - V)}{V} \times R$$

Therefore, we have
$$r = \frac{(2.2 - 1.8)}{1.8} \times 5$$
$$= 1.11 \text{ ohm}$$
or
$$V = IR$$
$$I = \frac{1.8}{5} = 0.36\ A$$
$$E - V = Ir$$
$$2.2 - 1.8 = 0.36 \times r$$
$$0.4 = 0.36\, r$$
$$r = \frac{0.4}{0.36} = 1.11\,\Omega$$

504. A piece of wire having resistance R is cut into four equal parts.
(a) How will the resistance of each part compare with the original resistance ?
(b) If the four parts are placed in parallel, how will the joint resistance compare with the resistance of the original wire ?

Ans : COMP 2012

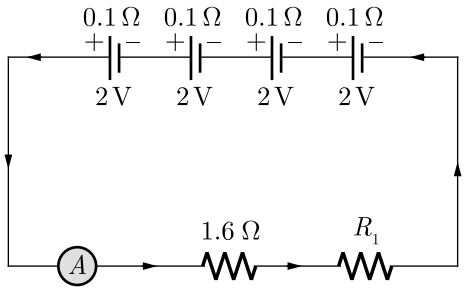
(a) Since the wire is divided into four equal parts, therefore, the new length of each part becomes one-fourth of the original. Since resistance is directly proportional to length, hence the resistance of each part becomes one-fourth of the original i.e., $R_N = R/4$.

(b) When these four parts are connected in parallel, the equivalent resistance becomes
$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$
$$= \frac{4}{R} + \frac{4}{R} + \frac{4}{R} + \frac{4}{R} = \frac{16}{R}$$
Hence, $R_P = R/16$ ohm

505. Four cells each of emf 2 V and internal resistance 0.3 ohm are connected in series. The combination is connected in series to an ammeter of negligible resistance, a 1.6 ohm resistor and an unknown resistor R_1. The current in the circuit is 2 A.
(a) Draw a labelled circuit diagram for the above arrangement and
(b) Calculate :
(i) the total resistance of the circuit
(ii) the total emf
(iii) the value of R_1 and
(iv) the potential difference across R_1.

Ans : SQP 2009

(a) The labelled diagram is an shown below :



(b) Total internal resistance
$$= 4 \times 0.1\,\Omega = 0.4\,\Omega$$

(i) Total resistance $= 1.6 + 0.4 + R_1$
$$= (2 + R_1)\,\Omega$$

NODIA

(ii) Total emf $= (2+2+2+2)\,V$
$= 8$ V

(iii) Here, $I = \dfrac{\text{Total emf}}{\text{Total resistance}}$

$2 = \dfrac{8}{2+R_1}$ or

$2R_1 + 4 = 8$ or $R_1 = 2\,\Omega$

(iv) Potential difference across R_1
$= IR_1 = 2 \times 2 = 4$ V

Hence,
Total resistance $= 2+2$
$= 4\,\Omega$ (as $R_1 = 2\,\Omega$)

506. An electrical heater is rated 4 KW, 220 V. Calculate: (i) The current, (ii) Resistance of the heater, (iii) Energy consumed in 2 hrs., (iv) Total cost if 1 kWh is charged at ₹ 0.50.

Ans : SQP 2009

Given, Power, $P = 4$ KW, $V = 220$ Volt,
$t = 2$ h

(i) Current, $I = \dfrac{P}{V}$
$= \dfrac{4000}{220} = \dfrac{200}{11} = 18.2$ A

(ii) Resistance, $R = \dfrac{V}{I} = \dfrac{220}{18.2} = 12.1\,\Omega$

(iii) Energy consumed $= V \times I \times t$
$= 220 \times 18.2 \times 2$
$= 8000$ Wh $= 8$KWh

(iv) Total cost $= 8 \times 0.50 =$ ₹ 4.00

507. A 25 W and a 100 W bulb are joined in series and connected to the A.C. mains. Which bulb will glow brighter?

Ans : COMP 2015

We know that $P = \dfrac{V^2}{R}$,

Where V is constant potential difference

Therefore, $\dfrac{R_{25}}{R_{100}} = \dfrac{P_{100}}{P_{25}} = \dfrac{100}{25} = 4$

i.e., the resistance of 25 W bulb is 4 times the resistance of 100 W bulb.
When both bulbs are put in series, the current passing through each of the bulb is the same.
Therefore, ratio of power dissipated is

$$\frac{P'_{25}}{P'_{100}} = \frac{I^2 R_{25}}{I^2 R_{100}} = \frac{R_{25}}{R_{100}} = 4$$

Therefore, bulb of 25 W will glow brighter.

508. (a) Calculate the quantity of heat that will be produced in a coil of resistance 75 Ω if a current of 2 A is passed through it for 2 minutes.
(b) (i) A substance has nearly zero resistance at a temperature of 1 K. What is such a substance called?
(ii) State any two factors which affect the resistance of a metallic wire.

Ans : MAIN 2015

(a) Given,
$R = 75\,\Omega,\ i = 2$ A, $t = 2$ min $= 120$ s
Heat produced in the coil,

$H = i^2 Rt$
$= (2)^2 \times 75 \times 120$
$= 36000$ J

(b) (i) Superconductor
(ii) Resistance of a metallic wire depends on
1. length of the wire ($R \propto l$)
2. area of cross-section $\left(R \propto \dfrac{1}{A}\right)$
3. temperature

509. A wire of resistance 6 Ω is drawn out so that its length is increased to twice its length. Calculate its new resistance.

Ans : MAIN 2015

We know that,

$$R = \rho\frac{l}{a} = \rho\frac{l^2}{a \times l} = \frac{\rho l^2}{V}$$

Where V is the volume of the conductor. Since ρ and V are constants.

$R \propto l^2$

$\dfrac{R_2}{R_1} = \dfrac{l_2^2}{l_1^2} = \left(\dfrac{l_2}{l_1}\right) = n^2$

$R_2 = n^2 R_1$

Here, $n = 2$

$R_2 = 4R_1 = 4 \times 6$

$R_2 = 24\,\Omega$

510. A heating coil is immersed in a calorimeter of heat capacity $50\,\text{J}^\circ\text{C}^{-1}$ containing 1.0 kg of a liquid of specific heat capacity $450\,\text{J kg}^{-1}{}^\circ\text{C}^{-1}$. The temperature of liquid rises by 10°C when 2.0 A current is passed for 10 minutes. Find: (i) the resistance of the coil, (ii) the potential difference across the coil. State the assumption used in your calculations.

Click Here to Buy book on Amazon

CHAPTER 7

HEAT

SUMMARY

1. HEAT

Heat is a form of energy in transit which flows from one part of a system to another part of the system or from one system to another system by virtue of temperature difference only. Heat is the measure of total internal energy possessed by the molecules of a body and is symbolized by Q . Internal (or thermal) energy is the kinetic and/or potential energy of the atoms/molecules of a body. SI unit of heat is joule but old units calorie and kilo-calorie are also used.

One calorie is the quantity of heat required to raise the temperature of 1 g of pure water by 1°C (from 14.5°C to 15.5°C).

$$1 \text{ calorie} = 4.186 \text{ joule} = 4.2 \text{ joule}$$

One kilo-calorie is the quantity of heat required to raise the temperature of 1 kg of pure water by 1°C (from 14.5°C to 15.5°C).

$$1 \text{ kcal} = 4.186 \times 10^3 \text{ joule}$$

$$\approx 4200 \text{ joule}$$

Here in the definition of calorie and kilo-calorie temperature range 14.5°C to 15.5°C is specified because quantity of heat required to raise the temperature through 1°C is not same at all the temperatures due to non-uniform expansion of water near 4°C but it is uniform and smooth beyond 14°C.

The "calorie" used in nutrition is really a kilo-calorie.

2. TEMPERATURE

Temperature is the measure of hotness (or coolness) of a body or it is the quantity which determines the direction of flow of heat as heat flows from higher temperature to lower temperature. The SI unit of temperature is K. But commonly degree celsius is also used.

NODIA

3. THERMAL (OR HEAT) CAPACITY

Thermal (or heat) capacity of a body is defined as the amount of heat required to increase its temperature by 1°C or 1 K. It is represented by C'.

By definition,

$$\text{Heat capacity, } C' = \frac{\text{Heat supplied } (Q)}{\text{Change in temperature } (\Delta T)}$$

SI unit of thermal (or heat) capacity is joule/kelvin denoted by J/K which is the same as J/°C $\{\Delta T = 1\,\text{K} = 1^\circ\text{C}\}$. But old units are also used which are cal/°C, cal/K, kcal/°C or kcal/K.

4. SPECIFIC HEAT CAPACITY

Specific heat capacity of a substance is defined as the amount of heat required to increase the temperature of unit mass of that substance through 1°C. It depends on the nature of the substance. By definition,

$$\text{Specific heat capacity } (c) = \frac{\text{Heat supplied } (Q)}{\text{Mass of the substance } (m)} \times \text{Rise in temperature } (\Delta T)$$

or $$Q = mc\,\Delta T$$

SI unit of specific heat capacity is J/kg K or $\text{J kg}^{-1}\text{K}^{-1}$ but other units $\text{J kg}^{-1}{}^\circ\text{C}^{-1}$, cal $\text{g}^{-1}{}^\circ\text{C}^{-1}$ kcal $\text{kg}^{-1}{}^\circ\text{C}^{-1}$ are also used.

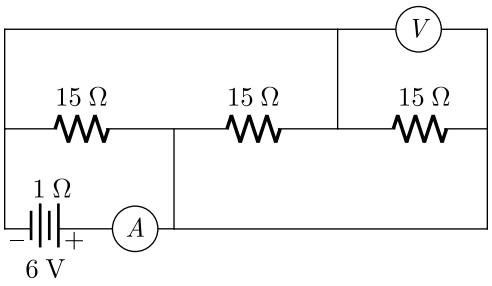
On keeping the two bodies in contact, if there is no exchange of heat between them, the bodies are said to be in the state of thermal equilibrium.

5. PRINCIPLE OF CALORIMETRY (OR METHOD OF MIXTURES)

Calorimetry deals with the measurement of heat. The copper vessel which is generally used in such measurement is called calorimeter.

When a hot body is mixed or kept in contact with a cold body, there is a transfer of heat from the body at higher temperature to a body at lower temperature till both the bodies attain the same temperature, i.e. heat lost by the hot

514. Find the ammeter and the voltmeter reading shown in figure.



Ans : COMP 2006

On examining the circuit carefully, we find that all the three resistors are connected in parallel with each other. Therefore, equivalent resistance of the combination is

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$= \frac{1}{15} + \frac{1}{15} + \frac{1}{15}$$

$$\frac{1}{R_P} = \frac{3}{15} = \frac{1}{5}$$

$$R_P = 5 \text{ ohm}$$

Since the internal resistance of the cell is 1 ohm, therefore, total resistance of the combination is

$$R = 1 + R_P$$

$$= 1 + 5 = 6 \text{ ohm}$$

Hence, total current in the circuit

$$I = \frac{V}{R} = \frac{6}{6} = 1A$$

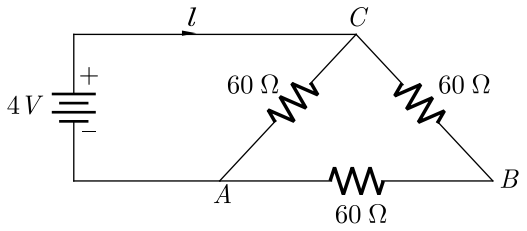
This current gets divided equally amongst the three resistors, therefore, current through each resistor connected in parallel is $\frac{1}{3}A$.

Therefore, potential difference across resistors is

$$V = IR = \frac{1}{3} \times 15 = 5 \text{ Volt}$$

This gives the reading of the voltmeter.

515. Find the value of the current in the circuit shown in the figure.



Ans : SQP 2006

In the circuit shown resistances AB and BC are in series

i.e. $$R_s = R_{AB} + R_{BC}$$

$$= 60\,\Omega + 60\,\Omega = 120\,\Omega$$

Resistance of arm AC, R_{AC} is in parallel with R_s

Hence $$\frac{1}{R_p} = \frac{1}{R_{AC}} + \frac{1}{R_s}$$

$$= \frac{1}{120} + \frac{1}{60}$$

$$= \frac{3}{120} = \frac{1}{40}$$

Hence, $$R_p = 40\,\Omega$$

Hence, current, $$i = \frac{V}{R_p}$$

$$= \frac{4\text{ V}}{40\,\Omega} = 0.1\text{ A}$$

516. A cell of emf 2.0 V is connected to an external resistance of 5 Ω when potential difference recorded at its terminals is 1.8 V. Calculate internal resistance of cell

Ans : SQP 2002

Given, $$E = 2.0 \text{ Volt}$$

$$V = 1.8 \text{ Volt}$$

$$R = 5\,\Omega$$

We know that, $$r = \frac{R(E - V)}{V}$$

$$r = \frac{5 \times (2.0 - 1.8)}{1.8}$$

$$r = 0.555\,\Omega = 0.56\,\Omega$$

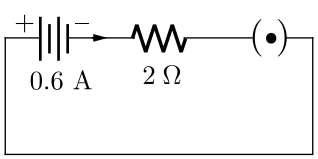
517. A cell supplies a current of 0.6 A through a 2 ohm coil and a current of 0.3 A through a 8 ohm coil. Calculate the emf and the internal resistance of the cell.

Ans : MAIN 2017

Given, $I_1 = 0.6\text{ A}$, $R_1 = 2\,\Omega$, $I_2 = 0.3\text{ A}$, $R_2 = 8\,\Omega$,

$$I = \frac{E}{R + r}$$

(i) $$0.6 = \frac{E}{2 + r} \text{ and}$$



(ii) $$0.3 = \frac{E}{8 + r}$$

Downloaded from www.pdf.tube

Ans : COMP 2021

Heat capacity of calorimeter

$$mc = 50\ \text{J}^\circ\text{C}^{-1}$$

Mass of liquid, $M = 1.0\ \text{kg}$

Specific heat capacity of liquid

$$c' = 450\ \text{J kg}^{-1}{}^\circ\text{C}^{-1}$$

Rise in temperature $(T_2 - T_1) = 10^\circ\text{C}$

Current, $I = 2.0\ \text{A}$

$$t = 10\ \text{min} = 10 \times 60\ \text{s} = 600\ \text{s}$$

Total heat energy required = Heat energy required by the calorimeter + Heat energy required by the liquid

$$= (mc + Mc')(T_2 - T_1)$$

$$= [50 + 1.0 \times 450] \times 10$$

$$= 5000\ \text{Joule}$$

(i) If R is the resistance of coil, heat energy produced in the coil

$$= I^2Rt = (2)^2 \times R \times 600$$

$$= 2400\text{R Joule}$$

If there is no loss of heat,

Heat energy required = Heat energy produced

$$5000 = 2400\text{R}$$

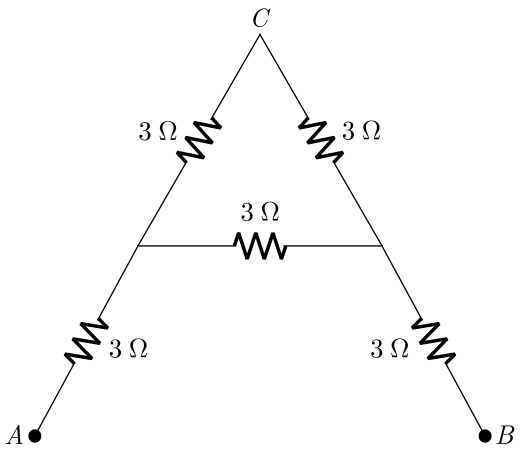
$$R = 5000/2400 = 2.08\ \Omega$$

(ii) Potential difference across the coil

$$V = IR = 2 \times 2.08 = 4.16\ \text{V}$$

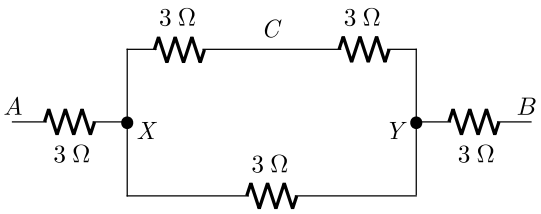
In the above calculations, we have assumed that there is no loss of heat.

511. In the diagram given below, calculate the resistance between the points (i) X and Y, (ii) A and B.



Ans : MAIN 2021

The equivalent circuit for the above circuit is as follows :



(i) The total resistance between X and Y is given by

$$\frac{1}{R} = \frac{1}{6} + \frac{1}{3}$$

$$= \frac{1+2}{6} = \frac{3}{6} = \frac{1}{2}\ \Omega$$

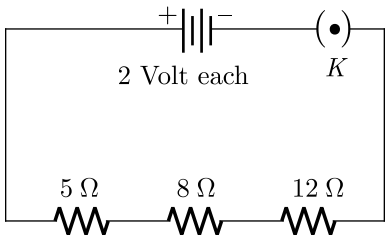
Hence, $R = 2\ \Omega$

(ii) Total resistance between A and B is given by

$$R' = 3 + 2 + 3 = 8\ \Omega$$

512. Draw a schematic diagram of a circuit consisting of a battery of four 2 volt cells, a 5 ohm resistor, an 8 ohm resistor and a 12 ohm resistor and a plug key all connected in series.

Ans : SQP 2021



513. A heater coil connected to 220 V has a resistance of 150 ohm. How long will it take this coil to heat 1 kg of water from 20°C to 60°C, assuming that all heat is taken up by water? Take specific heat of water as $4200\ \text{Jkg}^{-1}{}^\circ\text{C}^{-1}$.

Ans : SQP 2006

Given, $V = 220\ \text{Volt}$, $m = 1\ \text{kg}$, $R = 150\ \text{ohm}$

$$\Delta T = 60^\circ - 20^\circ = 40^\circ\text{C}$$

and $t = ?$

By conservation of energy, we have

$$\frac{V^2 t}{R} = mc\Delta T$$

$$t = \frac{m \times c \times \Delta T \times R}{V^2}$$

$$= \frac{1 \times 4200 \times 40 \times 150}{(220)^2} = 520.6\ \text{s}$$

NODIA

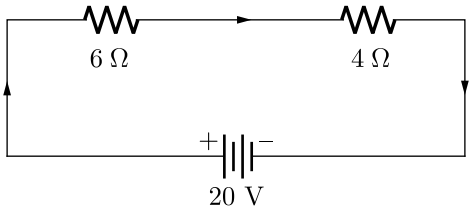
$$\left\{\frac{1}{R_{CD}}=\frac{1}{(2+3+5)}+\frac{1}{10}; R_{CD}=\frac{10\times 10}{10\times 10}\right\}$$

$$R_{AB}=12\,\Omega$$

522. A resistor of 6 ohm resistance is connected in series with another resistor of 4 ohm resistance. A potential difference of 20 volt is applied across the combination. Calculate the current through the circuit and the potential difference across the 6 ohm resistor.

Ans : MAIN 2013

The circuit diagram is as shown below :



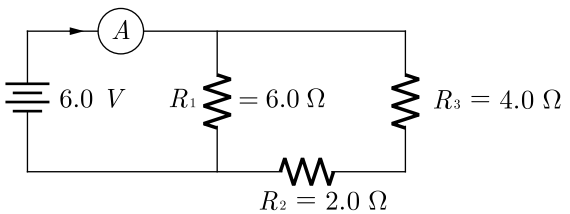
Given, $R_1 = 6$ ohm, $R_2 = 4$ ohm, $V = 20$ Volt, I = ? and V (across 6 ohm resistor) = ?
Since the two resistors are connected in series, therefore, the equivalent resistance of the combination is

$$R = R_1 + R_2 = 6 + 4 = 10\,\Omega$$

Now, current in the circuit can be obtained from Ohm's law as follows :

$$I = \frac{V}{R} = \frac{20}{10} = 2\text{ A}$$

523. Three resistors of $6.0\,\Omega$, $2.0\,\Omega$ and $4.0\,\Omega$ respectively are joined together as shown in the figure. The resistors are connected to an ammeter and to a cell of e.m.f. 6.0 V. Calculate :



(a) the effective resistance of the circuit.
(b) the current drawn from the cell.

Ans : SQP 2017

(a) $R_s = 2 + 4 = 6\,\Omega$

$$R_p = \frac{6}{2} = 3\,\Omega$$

(b) $$I = \frac{E}{R} = \frac{6}{3} = 2.0\text{ A}$$

524. An electrical heater is rated 4 KW, 220 V. Find the cost of using this heater for 12 hours if one kWh of electrical energy costs ₹ 3.25.

Ans : COMP 2017

$$\text{Electrical energy consumed} = 4\text{ KW} \times 12\text{ h} = 48\text{ kWh}$$

$$\text{Cost of electrical energy} = 48 \times 3.25 = ₹\,156.00$$

525. An electric lamp marked 50 W is worked on 220 V mains. Find the resistance of the lamp and the current passing through it.

Ans : MAIN 2012

Given, Power = 50 W,
$V = 220$ Volt

Since, Power = $V \times I$, therefore,

$$50 = 220 \times I$$

$$I = \frac{50}{220} = 0.227\text{ A}$$

Therefore, $$R = \frac{V}{I} = \frac{220}{0.227}$$

$$= 969.16\text{ ohm}$$

526. A heating element is marked 210 V, 630 W. What is the current drawn by the element when connected to 210 V A.C. mains? What is the resistance of the element?

Ans : SQP 2012

Given, $P = 630$ W; $V = 210$ Volt

We know that, $$I = \frac{P}{V}$$

$$= \frac{630}{210} = 3\text{ A}$$

and $$R = \frac{V^2}{R}$$

$$= \frac{(210)^2}{630} = 70\text{ ohm}$$

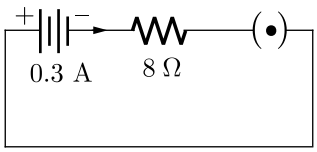
527. Two bulbs A and B are rated 100 W, 120 V and 10 W, 120 V respectively. They are connected in parallel across a 120 V source. Find the current through each bulb. Which bulb will consume more power?

Ans : MAIN 2009

Resistance of bulb A (rating 100 W, 120 V) is

$$R_A = \frac{V^2}{P_A} = \frac{(120)^2}{100} = 144\,\Omega$$

Click Here to Buy book on Amazon



From the above two, we have
As same cell is used
Hence, E is same so equation (i) = equation (ii)

$$0.6(2+r) = 0.3(8+r)$$

or $$0.3\,r = 12$$

$$r = 4 \text{ ohm}$$

Substituting the value of r in equation (i), we have

$$E = 0.6(2+4) = 3.6 \text{ V}$$

518. An electric heater is rated 500 KVA, 200 V. If the heater is operated for 3 hour, calculate the energy consumed :
(i) in kWh
(ii) in joule

Ans : COMP 2011

(i) $\text{Power} = 500 \text{ KVA} = 500 \text{ KW}$

$(VA = W, VI = P)$

$\text{Time} = 3 \text{ hours}$

$\text{Energy} = \text{Power} \times \text{Time}$

$= 500 \text{ KW} \times 3 \text{ h}$

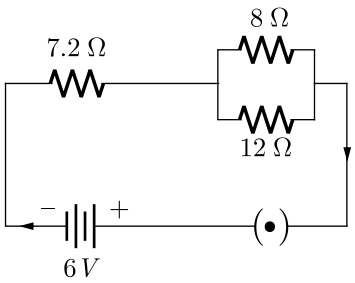
$\text{Energy} = 1500 \text{ kWh}$

(ii) $1 \text{ kWh} = 3.6 \times 10^6 \text{ J}$

$1500 \text{ kWh} = 1500 \times 3.6 \times 10^6 \text{ J}$

$\text{Energy} = 5.4 \times 10^9 \text{ J}$

519. Three resistors are connected to a 6 V battery as shown in the given figure:



Calculate:
(a) the equivalent resistance of the circuit.
(b) total current in the circuit.
(c) potential difference across the 7.2 Ω resistor.

Ans : MAIN 2011

(a) The equivalent resistance of the circuit is

$$= 7.2\,\Omega + \frac{8\,\Omega \times 12\,\Omega}{8\,\Omega + 12\,\Omega}$$

$$= 7.2\,\Omega + \frac{96}{20}\Omega$$

$$= 7.2\,\Omega + 4.8\,\Omega = 12.0\,\Omega$$

(b) Total current in the circuit

$$i = \frac{6 \text{ V}}{12\,\Omega} = 0.5 \text{ A}$$

(c) Potential difference across 7.2 Ω resister

$$= 0.5 \text{ A} \times 7.2\,\Omega$$

$$= 3.6 \text{ V}$$

520. Calculate the electrical energy consumed when a bulb of 40 W is used for 12.5 hours everyday for 30 days.

Ans : SQP 2008

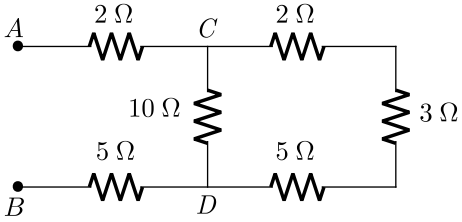
Electrical energy consumed in 30 days

$$= \text{Power} \times \text{Time}$$

$$= 30 \times \left(\frac{40}{1000}\text{KW} \times 12.5 \text{ h}\right)$$

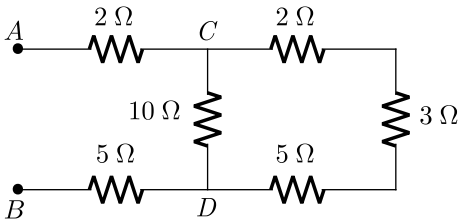
$$= 15 \text{ kWh}$$

521. Six resistances are connected together as shown in the figure.



Calculate the equivalent resistance between the points A and B.

Ans : MAIN 2003

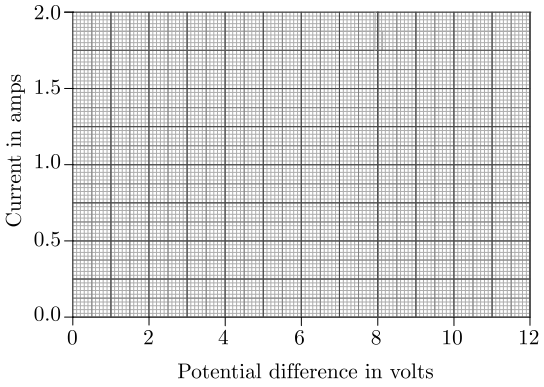


The equivalent resistance between the points A and B is

$$R_{AB} = R_{AC} + R_{CD} + R_{DB}$$

$$R_{AB} = 2\Omega + \left(\frac{10 \times 10}{10 \times 10}\right)\Omega + 5\,\Omega$$

NODIA



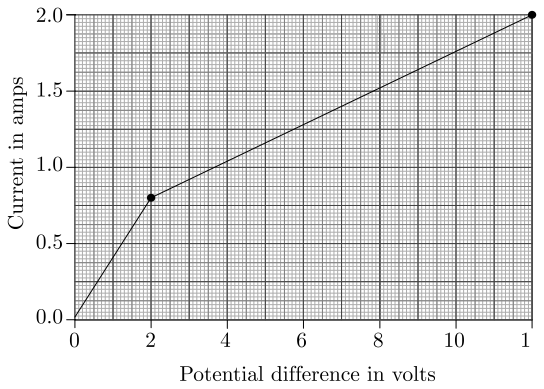
(iii) Why does the resistance of the lamp change when the current through the lamp exceeds 0.8 A?

Ans :

(i) Potential difference = Current × resistance

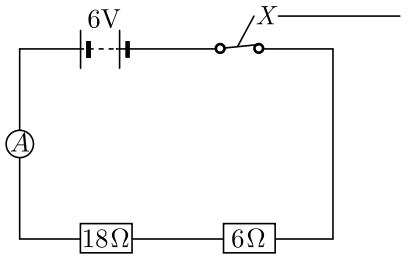
$= 0.8 \times 2.5 = 2$ V

(ii)



(iii) The resistance of a filament lamp increases as the potential difference increases because the filament becomes hot. The movement of electrons (which is what causes the current) makes the atoms inside the filament vibrate faster and this makes the filament heat up.

531. A circuit diagram is shown below.



(i) Use a word from the box to label component X.

fuse	switch	thermistor

(ii) Calculate the total resistance of the two resistors in the circuit.

(iii) The 6 V battery is made by correctly joining several 1.5 V cells in series. Calculate the number of cells needed to make the battery.

Ans :

(i) switch

(ii) In the given circuit diagram resistances are connected in series.

Hence the total resistance of circuit

$= 18+6 = 24\,\Omega$

(iii) Number of required cell is given by

$= \frac{6}{1.5} = 4$

532. The picture shows a person using a set of electronic 'Body Fat Scales'. When the person stands on the scales, a small, harmless, electric current passes through the person's body.

The scales then calculate the resistance of the person's body and convert the resistance into a prediction of body fat content.

(i) The scales contain two 3 V cells joined in series. Calculate the resistance of a person's body, if when he stands on the scales, a current of 0.12 mA passes through his body.

(ii) The scales can only produce a prediction of body fat content and not an accurate measurement. Suggest why.

(iii) It is recommended that the scales are not used immediately after a person has drunk a large amount of water. Suggest why.

Resistance of bulb B (rating 10 W, 120 V) is

$$R_B = \frac{V^2}{P_B} = \frac{(120)^2}{10} = 1440\,\Omega$$

As the bulbs are connected in parallel across a 120 V source, the voltage is the same (= 120 V) across each bulb.

Current in the bulb A,

$$I_A = \frac{V}{R_A} = \frac{120}{144} = 0.83\text{ A}$$

Current in the bulb B,

$$I_B = \frac{V}{R_B} = \frac{120}{1440} = 0.083\text{ A}$$

Power consumed by the bulb A will be 100 W and by the bulb B will be 10 W as per their specifications since both the bulb operate at their rated voltage (= 120 V). Obviously, the bulb A (with rating 100 W, 120 V) consumes more power than the bulb B (with rating 10 W, 120 V).

CASE BASED QUESTION

528. A set of Christmas tree lights is made from twenty identical lamps connected in series.

Each lamp is designed to take a current of 0.25 A. The set plugs directly into the 230 V mains electricity supply.

(i) Write down the equation that links current, potential difference and resistance.

(iii) What is the total resistance of the set of lights ?

(iii) Calculate the resistance of one of the lamps.

Ans :

(i) Potential difference = current × resistance

(ii) $\text{Total resistance} = \dfrac{\text{Potentaial difference}}{\text{Current}}$

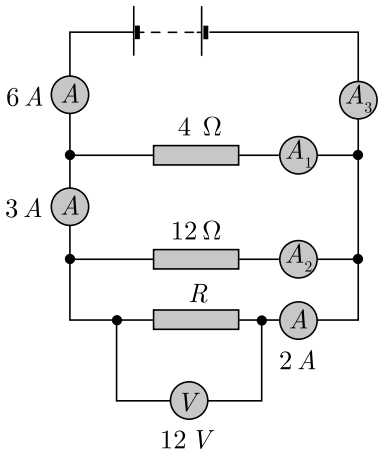
$$= \frac{230}{0.25} = 920\,\Omega$$

(iii) Resistance of each lamp

$$= \frac{\text{Total resistance}}{\text{Number of lamps}}$$

$$= \frac{920}{20} = 46\Omega$$

529. A student sets up the circuit shown in the diagram.



(i) State the equation that links voltage, current and resistance.

(ii) Calculate the value of the resistance, R. State the unit of resistance.

(iii) State the voltage of the battery. Explain your answer.

Ans :

(i) Resistance = voltage ÷ current

(ii) $R = \dfrac{12}{2}$

$= 6$ ohms

(iii) The battery voltage is 12 V. It is the same as the voltmeter reading. There is 12 V across each resistor, because they are in parallel.

530. The resistance of a 24 W, 12 V filament lamp depends on the current flowing through the lamp. For currents up to 0.8 A, the resistance has a constant value of 2.5 Ω.

(i) Calculate the potential difference across the lamp when a current of 0.8 A flows through the lamp.

(ii) When the potential difference across the lamp is 12 V, the current through the lamp is 2 A. On the axes below, draw a current–potential difference graph for the filament lamp over the range of potential difference from 0 to 12 volts.

Downloaded from www.pdf.tube

536. *A* student used some everyday items to investigate static electricity. Figure 1 shows a flexible plastic strip being rubbed with a cloth.

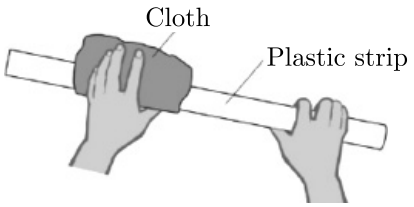


Figure 1

(i) Complete the sentence.
(a) Rubbing the plastic strip with the cloth causes the strip to become negatively charged because .....(electrons/ neutrons/protons) move from the cloth onto the plastic strip.
(b) The cloth is left with ..... (a negative/a positive/zero) charge.

(ii) The student hung the plastic strip over a wooden rod. The ends of the strip moved away from each other.
Figure 2 shows the position of the plastic strip on the wooden rod.

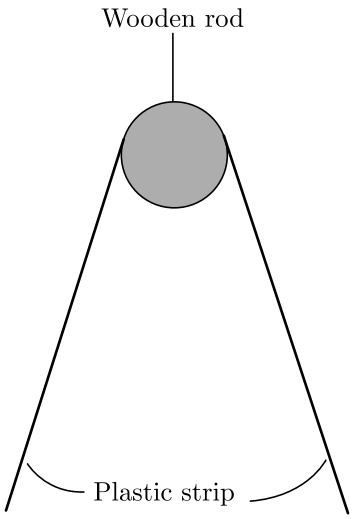


Figure 2

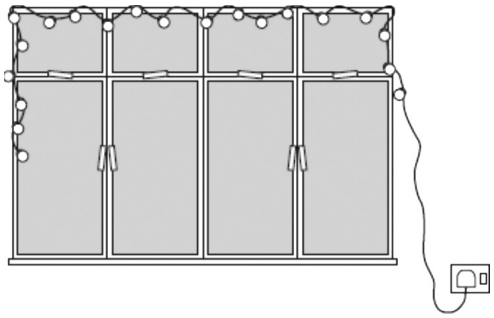
What two conclusions should the student make about the forces acting on the two halves of the plastic strip?

Ans :

(i) (a) electrons
(b) a positive

(ii) The forces are repulsive acts in the opposite directions whose magnitude is same.

537. A set of lights consists of 20 lamps connected in series to the 230 V mains electricity supply.



When the lights are switched on and working correctly, the current through each lamp is 0.25 *A*.

(i) What is the total current drawn from the mains supply?

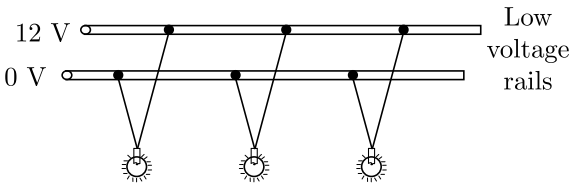
(ii) Calculate the charge passing through one of the lamps in 5 minutes. Show clearly how you work out your answer and give the unit.

Ans :

(i) Total current = Current through one lamp × Number of lamps
$= 0.25 \times 1 = 0.25$ A

(ii) Charge = Current × Time
$= 0.25 \times 5 \times 60$
$= 75$ C

538. The diagram shows a 12 volt lighting system. Each lamp has a power of 32 watts.



(i) Write down the equation that links current, potential difference and power.

(ii) Calculate the input current to the lighting system. Show clearly how you work out your answer.

Ans :

(i) Power = Potential difference × current accept

(ii) $\text{Input current} = \frac{\text{Power}}{\text{Potential difference}}$
$= \frac{32}{12} = 2.67$ A

NODIA
www.nodia.in

Ans :

(i) $V = IR$

$6 = 0.00012 \times R$

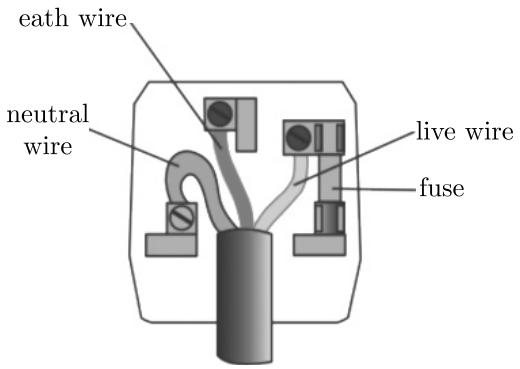
$R = \frac{6}{0.00012}$

$= 50000\ \Omega = 50\ \text{k}\Omega$

(ii) Body fat prediction by scales may not provide accurate measurements due to variations in body composition, hydration levels, and other factors influencing bioelectrical impedance analysis.

(iii) After consuming a large amount of water can lead to unreliable results due to rapid changes in hydration status affecting electrical impedance measurements.

533. The diagram shows the connections inside a Indian mains plug. It contains a fuse.



(i) Explain why the wires are covered in plastic.

(ii) Describe how a fuse acts as a safety device.

(iii) State whether the fuse is placed in the circuit in the live wire, the neutral wire or the earth wire.

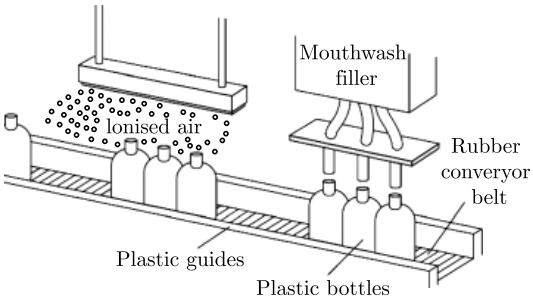
Ans :

(i) The outer covering of electric wires is made of plastic because plastic is an insulator.

(ii) When fuse wire melts, the circuit is broken and in this way, it prevents damage to electrical appliances and avoids fire.

(iii) Live wire

534. A company that produces bottles of mouthwash found a problem with the automatic filling system. As the bottles go towards the filler, the bottles move around on the conveyor belt and become electrostatically charged. This causes the stream of mouthwash to move sideways, missing the open top of the bottle.



The company came up with an answer to the problem. Before the bottles reach the filler, the bottles pass through a stream of ionized air. The ions in the air neutralize the charge on the bottles.

(i) Explain why the plastic bottles became charged.

(ii) What happens to the structure of an atom to change the atom into an ion?

Ans :

(i) Due to the friction between bottles and conveyor belt the plastic bottales becomes charged.

(ii) The atom loses or gains one or more electrons

535. The picture shows an electric bicycle. The bicycle is usually powered using a combination of the rider pedalling and an electric motor.

A 36 volt battery powers the electric motor. The battery is made using individual 1.2 volt cells.

(i) Explain how a 36 volt battery can be produced using individual 1.2 volt cells.

(ii) The battery supplies a direct current d.c.. What is a direct current d.c.?

Ans :

(i) Number of cell $= \frac{36}{1.2}$

$= 30$ cells

(ii) Direct current (DC) is an electric current that is uni-directional, so the flow of charge is always in the same direction.

Download NODIA App for All Sample Papers PDFs

Click Here to Buy book on Amazon

body is equal to the heat gained by the cold body provided there is no heat loss to the surrounding. This principle of calorimetry is based on the law of conservation of energy.
Heat lost by hot body = Heat gained by cold body

6. CHANGE OF STATE

Change of state is the process of change from one state of matter to another at constant temperature.

6.1 Fusion or Melting

Fusion or melting is the change of state from solid to liquid on heating and the constant temperature at which this change takes place is called melting point.

6.2 Freezing

Freezing is the process of the change of liquid into solid on cooling and the constant temperature at which this process takes place is called freezing point.

6.3 Vaporisation

Vaporisation is the process of change of state of liquid to gaseous state and the constant temperature at which this process takes place is called boiling point or ebullition point of the liquid. The reverse process, i.e. change from gaseous state to liquid state at constant temperature is called condensation.

6.4 Sublimation

Sublimation is the process of change of state from solid to gaseous directly. The reverse of this process is called hoar frost.

7. LATENT HEAT

Latent heat is the amount of hidden heat supplied/extracted from the unit mass of the substance to change its state without any change of temperature, i.e. from solid to liquid or from liquid to solid.

Latent heat is the increase in potential energy of the molecules. There is no increase in kinetic energy during melting and hence no increase in temperature.

7.1 Specific Latent Heat of Fusion

Specific latent heat of fusion (or heat of fusion) of a substance is the amount of heat required to convert unit mass of solid into liquid at its melting point without any change in its temperature.
Specific latent heat of fusion (L)

$$= \frac{\text{Heat supplied } (Q)}{\text{Mass of the substance } (m)}$$

7.2 Specific Latent Heat of Vaporisation

Specific latent heat of vaporisation (or heat of vaporisation) of a substance is the amount of heat required to convert unit mass of the liquid into vapour at its boiling point without any change in its temperature.
Specific latent heat of vaporisation (L)

$$= \frac{\text{Heat supplied } (Q)}{\text{Mass of the substance } (m)}$$

or $Q = mL$

The SI unit for specific latent heat of fusion/ vaporisation is J/kg. Some other units are J/g, cal/g, kcal/kg.

NODIA

8. BOILING (OR EBULLITION) POINT

Boiling (or ebullition) point is the temperature at which the pressure exerted by the vapours of the liquid is equal to the normal atmospheric pressure.
Evaporation is affected by the following factors:
(i) The area of the exposed surface
(ii) The dryness of air
(iii) The velocity of the air
(iv) The temperature of the liquid
(v) Nature of the liquid
(vi) Pressure of the air.

MULTIPLE CHOICE QUESTION

1. Heat capacity of a body is the:
(a) energy needed to melt a body without change in its temperature.
(b) energy needed to raise the temperature of a body by 1°C
(c) increase in volume of the body when its temperature increases by 1°C
(d) total amount of internal energy that is constant.

Ans : SQP 2025

Heat capacity of a body is the energy needed to raise the temperature of the body by 1°C.
Thus (b) is correct option.

Latent heat of solid,

$$L = \frac{640}{80} = 8 \text{ Jg}^{-1}$$

Thus (a) is correct option.

15. A copper ball is dropped from a vertical height of 1200 m. If the initial temperature of copper ball at the height is 12°C, what is its temperature of copper is 400 $\text{Jkg}^{-1}\,^{\circ}\text{C}^{-1}$ and $g = 10$ ms^{-2}.

(a) 24°C (b) 84°C
(c) 48°C (d) 42°C

Ans : COMP 2020

Let m be the mass of copper ball K.E. of falling ball = P.E. at the top = mgh

K.E of falling ball = Heat produced in ball

$$\text{mgh} = mc\Delta t$$
$$10 \times 1200 = c \times \text{rise in temp.}$$
$$c \times \Delta t = 10 \times 1200$$
$$400\,\Delta t = 12000$$
$$\Delta t = \frac{12000}{400} = 30$$
$$(T - 12) = 30$$

Hence, Final temperature on reaching the ground $T = 30 + 12 = 42°\text{C}$
Thus (d) is correct option.

16. A copper calorimeter contains 50 g of water at 16°C. When 40 g of water at 36°C is added, the resulting temperature of the mixture is 24°C. Calculate the heat capacity of the calorimeter.

(a) 42 $\text{J}^{\circ}\text{C}^{-1}$ (b) 4 $\text{J}^{\circ}\text{C}^{-1}$
(c) 24 $\text{J}^{\circ}\text{C}^{-1}$ (d) 2 $\text{J}^{\circ}\text{C}^{-1}$

Ans : COMP 2011

Let $mc = x$ be the heat capacity of calorimeter resulting temp. of mixture = 24°C
on adding hot water at 36°C when added to cold water at 16°C, hot water loses heat and cold water and calorimeter gains heat till the temperature becomes 24°C.
Heat gained by calorimeter + cold water

$$= (x + 50 \times 4.2)(24 - 16)$$
$$= (x + 210) \times 8$$

Heat lost by hot water

$$= (40 \times 4.2) \times \text{fall in temp.}$$
$$= (4 \times 42) \times (36 - 24)$$
$$= 168 \times 12 \text{ J}$$

Heat gained = Heat lost

$$(x + 210)\,8 = 168 \times 12$$
$$x = 210 - \frac{168 \times 12}{8}$$
$$x = 252 - 210$$
$$= 42\,\text{J}^{\circ}\text{C}^{-1}$$

Heat capacity calorimeter = $42\,\text{J}^{\circ}\text{C}^{-1}$.
Thus (a) is correct option.

17. In an industrial process 10 kg of water per hour is to be heated from 20°C to 80°C. To do this, steam at 150°C is passed from a boiler into a copper coil immersed in water. The steam condenses in the coil and is returned to the boiler as water at 90°C, how many kg of steam is required per hour ?
(Take, specific heat of steam = 1 cal per g°C and latent heat of evaporation = 540 cal g^{-1})

(a) 1 g (b) 10 g
(c) 1 kg (d) 10 kg

Ans : MAIN 2009

Let steam required per hour = m kg
Heat released by steam in following three steps
(i) When steam at 150°C $\xrightarrow{Q_1}$ Steam at 100°C

$$Q_1 = mc_s\,\Delta t$$
$$= m \times 1\,(150 - 100)$$
$$= 50 \text{ m cal}$$

(ii) When steam at 100°C $\xrightarrow{Q_2}$ Water at 100°C

$$Q_2 = mL_v = m \times 540$$
$$= 540 \text{ m cal}$$

(iii) When water at 100°C ⟶ Water at 90°C

$$Q_3 = mc_w\,\Delta t$$
$$= m \times 1 \times (100 - 90)$$
$$= 10 \text{ m cal}$$

Hence, total heat lost by the steam,

$$Q = Q_1 + Q_2 + Q_3$$
$$= 50 + 540 + 10$$
$$= 600 \text{ m cal}$$

Heat absorbed by 10 kg water,

$$Q' = mc_w\,\Delta t$$
$$= 10 \times 10^3 \times 1 \times (80 - 20)$$
$$= 600 \times 10^3 \text{ cal}$$

Hence, $Q = Q'$

$$600\,m = 600 \times 10^3$$
$$m = 10^3 \text{g} = 1 \text{ kg}$$

Thus (c) is correct option.

Downloaded from www.pdf.tube

$$m \times 80 = 4000$$

$$\text{Mass of melted ice } m = \frac{4000}{80} = 50 \text{ g}$$

Thus (c) is correct option.

9. S.I. unit of thermal capacity is :
(a) Jkg^{-1} (b) $J\,K^{-1}$
(c) $kJ\,Kg^{-1}$ (d) cal $°C^{-1}$

Ans : COMP 2007

Thermal capacity is also termed heat capacity. Thermal capacity is a physical property of matter that denotes the amount of heat to be supplied to a given mass of a material to produce a unit change in its temperature. The SI unit of heat or thermal capacity is joules per kelvin(JK^{-1}).
Thus (b) is correct option.

10. Which of the following is not a greenhouse gas?
(a) ozone (b) methane
(c) carbon dioxide (d) chlorofluorocarbons

Ans : MAIN 2005

Greenhouse gases are called so because they are capable of absorbing the insolation from the sun and keeping it within the troposphere, thereby increasing the overall temperature of the earth, called global warming. Carbon dioxide, methane, nitrous oxide, ozone, Chlorofluorocarbons and sulphur hexafluoride are considered to be the potent greenhouse gases. Oxygen is not a greenhouse gas.
Thus (a) is correct option.

11. The base of cooking pans is made thicker and heavy because
(a) it increases the heat capacity of pan.
(b) the food does not get charred and keeps hot for long time.
(c) it lowers the heat capacity of pan.
(d) both (a) and (c)

Ans : COMP 2001

The base of cooking pans is made thick and heavy to increase the heat capacity of a pan and the food does not get charred and keeps hot for a long time.
Thus (d) is correct option.

12. What mass of a solid of specific heat capacity 0.75 $Jg^{-1}\,°C^{-1}$ will have heat capacity 93.75 $Jg^{-1}\,°C^{-1}$?
(a) 25 g (b) 225 g
(c) 125 g (d) 325 g

Ans : SQP 2000

$$\text{Heat capacity} = \text{mass} \times \text{specific heat capacity}$$

$$93.75 = \text{mass} \times 0.75$$

$$\text{Mass} = \frac{93.75}{0.75} = 125 \text{ g}$$

Thus (c) is correct option.

13. How many grams of ice at $-14°C$ are needed to cool 200 g of water from 25°C to 10°C ? (Take, specific heat of ice = 0.5 cal $g^{-1}\,°C^{-1}$ and latent heat of ice = 80 cal g^{-1})
(a) 27 g (b) 20 g
(c) 30 g (d) 31 kg

Ans : MAIN 2000

$$\text{Heat gained by ice} = \text{Heat lost by water}$$

Let $m_1 =$ mass of ice

$L_{ice} = 80$ cal/g

$c_{ice} = 0.5$ cal/g/°C

Temperature of ice $= -1.4°C$

Heat gained by ice

$$= m_1 L + m_1 c_{ice} \Delta t + m_1 c_{water} \Delta t$$

$$= m[L + c_{ice} \Delta t + c_{water} \Delta t]$$

$$= m[80 + 0.5(0 + 14) + 1 \times (0 + 25)]$$

$$= m[80 + 7 + 25]$$

$$= m \times 112 \quad \ldots(i)$$

Heat lost by water

$$= 200 \times 1 \times (25 - 10)$$

$$= 200 \times 15 \quad \ldots(ii)$$

From Eqs. (i) and (ii), we get

$$m \times 112 = 200 \times 15$$

$$m = \frac{200 \times 15}{112} = 26.7 = 27 \text{ g}$$

Thus (a) is correct option.

14. A solid of mass 80 g and at 80°C melts completely to form liquid at 80°C by absorbing 640 J of heat energy. What is the specific latent heat of fusion of solid ?
(a) 8 Jg^{-1} (b) 4 Jg^{-1}
(c) 2 Jg^{-1} (d) 10 Jg^{-1}

Ans : SQP 2011

Mass of solid, $m = 80$ g at 80°C

On melting 80 g of liquid at 80°C

$$mL = 640$$

$$80L = 640$$

$$= 110°C$$

Specific heat capacity $(c) = 750\ \text{Jkg}^{-1}°\text{C}^{-1}$

Heat energy given out $= m(c)\,\Delta t$

$$= \frac{2}{10} \times 750 \times 110$$

$$= 16500\ \text{J}$$

Thus (a) is correct option.

38. Heat energy is given to 80 g of alcohol (sp. heat capacity 2200 $\text{J kg}^{-1}\text{K}^{-1}$) when its temperature rises by 20 K. If the same heat energy is given to 200 g of mercury of specific heat capacity 140 $\text{J kg}^{-1}\text{K}^{-1}$, what is the rise in temperature.

(a) 152.7 K (b) 125.7 K
(c) 215.7 K (d) 251.7 K

Ans : MAIN 2009

Heat energy given to $\left(\frac{80}{1000}\text{kg}\right)$ of alcohol

$$= mC\Delta t$$

$$= \frac{80}{1000} \times 2200 \times 20$$

$$= 3520\ \text{J}$$

Energy given to $\frac{200}{1000}$ kg of mercury

$$\left(\frac{200}{1000}\right) \times 140 \times \Delta t = 3520$$

$$\Delta = \frac{3520}{28} = 125.7\ \text{K}$$

Thus (b) is correct option.

39. Your are required to make a water bath of 50 kg at 45°C, by mixing hot water at 90°C, with cold water at 20°C.
Calculate the amount of hot water required.
Hint : Let amount of hot water $= x$
Hence, Amount of cold water $= (50 - x)$ kg

(a) 7.871 kg (b) 27.871 kg
(c) 17.857 kg (d) 37.871 kg

Ans : SQP 2007

Total mixture of water $= 50$ kg

Resulting temp. $= \theta°\text{C}$

Let, mass of hot water $= x$ kg

Hence, mass of cold water $= (50 - x)$ kg

Heat lost by hot water = Heat gained by cold water

$$mC(T - \theta) = mC(\theta - t)$$

$$x \times 4200\,(90 - 45) = (50 - x)\,4200\,(45 - 20)$$

$$45x = 25\,(50 - x)$$

$$45x = 1250 - 25x$$

$$70x = 1250$$

$$\text{Mass of hot water} = \frac{1750}{70} = 17.857\ \text{kg}$$

Thus (c) is correct option.

40. A solid of mass 1.2 kg has specific heat capacity of 1.4 $\text{Jg}^{-1}\ °\text{C}^{-1}$. Calculate its heat capacity in SI units.

(a) 1680 JK^{-1} (b) 680 JK^{-1}
(c) 80 JK^{-1} (d) 1860 JK^{-1}

Ans : SQP 2019

Heat capacity = mass × specific heat capacity

$$= 1.2\ \text{kg} \times 1.4\ \text{Jg}^{-1}\,°\text{C}^{-1}$$

$$= 1.2\ \text{kg} \times 1.4 \times 1000\ \text{JKg}^{-1}\,°\text{C}^{-1}$$

$$= \frac{12}{10} \times \frac{14}{10} \times 1000$$

$$\left[\text{Since}, \frac{J}{g°\text{C}} = \frac{J}{\frac{g}{1000}°C} = 1000\ \text{JKg}^{-1}\,°\text{C}^{-1}\right]$$

Heat capacity $= 1680\ \text{JK}^{-1}$

Thus (a) is correct option.

41. 400 g of mercury of specific heat capacity 0.14 $\text{Jg}^{-1}\,°\text{C}^{-1}$ is heated by a 200 W heater for 1 min. and 40 s. If initially mercury is at 0°C, calculate its final temperature.

(a) 753.1°C (b) 537.1°C
(c) 735.1°C (d) 357.1°C

Ans : COMP 2011

Mass of mercury $m = 400$ g

$$C = 0.14\ \text{Jg}^{-1}\,°\text{C}^{-1}$$

Heat supplied in 1 minute $= P \times t$

and $40\ \text{S} = (200 \times 100)\ \text{J}$

Rise in temp. $\Delta t = (T - 0)\,°\text{C}$

Hence, $mc\Delta t = H$

$$400 \times \frac{14}{100} \times (T - 0) = (200 \times 100)$$

$$(T - 0) = \frac{200 \times 100}{4 \times 14}$$

$$= 357.1$$

Hence, $T = 357.1°\text{C}$

Thus (d) is correct option.

42. A piece of brass of mass 200 g and 100°C is placed in 400 g of turpentine oil, contained in a copper calorimeter of mass 50 g at 15°C. The final temperature recorded is 23°C. Find the sp. heat

Click Here to Buy book on Amazon

18. A solid of mass 150 g at 200°C is placed in 0.4 kg of water at 20°C till a constant temperature is attained. If the S.H.C. of the solid is 0.5 Jg^{-1} K^{-1}, find the resulting temperature of the mixture.

(a) 37.7°C (b) 27.7°C
(c) 47.7°C (d) 57.7°C

Ans : SQP 2010

For solid	**For water**
$M = 150$ g	$m = 0.4$ kg $= 400$ g
$T = 200^\circ C$	$t = 20^\circ C$
$C_1 = 0.5 = \frac{1}{2}$	$C_2 = 4.2 = \frac{42}{10}$

Let θ be the final temp.

Hence,Heat lost by solid = Heat gained by water

$$MC_1(T-\theta) = mC_2(\theta - t)$$

$$150 \times \frac{1}{2} \times (200-\theta) = 400 \times \frac{42}{10}(\theta - 20)$$

$$15000 - 75\theta = 16800 - 33600$$

$$(1680 + 75)\theta = 33600 + 15000$$

$$1755\theta = 48600$$

$$\theta = \frac{48600}{1755} = \frac{9270}{351}$$

$$= 27.7^\circ C$$

Thus (b) is correct option.

19. A power drill of 400 W makes a hole in a lead cube of specific heat capacity 0.13 Jg^{-1} $°C^{-1}$ in 80 s. If the temperature of lead rises from 27°C to 317°C, calculate the mass of the lead cube.

(a) 120.5 g (b) 420.5 g
(c) 820.5 g (d) 620.5 g

Ans : MAIN 2002

$$C = 0.13 \text{ g}^{-1} \text{ °C}^{-1}$$

Heat produced in 80s $= P \times t$

$$= (400 \times 80) \text{ J}$$

Rise in temp. $\Delta t = (327 - 27) = 300°C$

Mass of Lead $m = ?$

Hence, $mc\Delta t = H$

$$m \times 0.13 \times 300 = (400 \times 80)$$

$$m = \frac{(400 \times 80) \times 100}{300 \times 13}$$

$$= \frac{3200}{39} = 820.5 \text{ g}$$

Thus (c) is correct option.

20. A copper vessel contains 200 g of water at 24°C. When 112 g of water at 42°C is added, the resultant temperature of water is 30°C. Calculate the thermal capacity of the calorimeter.

(a) 1.8 J $°C^{-1}$ (b) 10.8 J $°C^{-1}$
(c) 1000.8 J $°C^{-1}$ (d) 100.8 J $°C^{-1}$

Ans : COMP 2015

Let $mc = x$ be the thermal capacity of calorimeter final temp. of mixture 30°C

Hence, Heat gained by cold water + calorimeter

$$= [x + m_1 \times 4.2] \times \text{rise in temp.}$$

$$= [x + (200 \times 4.2) \times (30 - 24)]$$

$$= (x + 840) \times 6$$

Heat lost by hot water

$$= [1124.2] \times \text{fall in temp.}$$

$$= (470.4)\ (42 - 30)$$

$$= (470.4) \times 12$$

$$\text{Heat lost} = \text{Heat gained}$$

$$(12 \times 470.4) = 6\ (C\ + 840)$$

$$(C\ + 840) = 2 \times 470.4$$

Heat capacity of calorimeter is given by

$$= 940.8 - 840$$

$$= 100.8 \text{ J}^\circ\text{C}^{-1}$$

Thus (d) is correct option.

21. A liquid x of specific heat capacity 1050 $J\,kg^{-1}K^{-1}$ and at 90°C is mixed with a liquid y of specific heat capacity 2362.5 $J\,kg^{-1}K^{-1}$ and 20°C, when the final temperature recorded is 50°C. Find in what proportion the weights of the liquids are mixed.

(a) 16 : 27 (b) 37 : 16
(c) 27 : 16 (d) 47 : 16

Ans : SQP 2007

Hence, Heat lost by x = Heat gained by y

$$\theta = 50^\circ C$$

$$m_1 C_n (T - \theta) = m_2 C_y (\theta - t)$$

$$x \times 1050\,(90 - 50) = y \times \frac{2362.5}{10}(50 - 20)$$

$$x \times 1050 \times 40 = y \times \frac{4725}{2} \times 30$$

Hence, $$\frac{x}{y} = \frac{4725 \times 15}{1050 \times 40}$$

$$\frac{x}{y} = \frac{27}{16}$$

Downloaded from www.pdf.tube

$$x : y = 27 : 16$$

Thus (c) is correct option.

22. A vessel from which the air is rapidly being pumped out contains 100 g of water at 0°C. The intensive evaporation causes a gradual freezing of the water. What part of the original water can be converted into ice by this method ?

(a) 60% (b) 78%
(c) 86.2% (d) 56%

Ans : COMP 2022

As latent heat of vaporisation of water at 0°C,

$$L_1 = 2.10 \times 10^6 \text{ J/kg}$$
$$= 2.10 \times 10^3 \text{ J/g}$$

Latent heat of fusion of ice

$$= 3.36 \times 10^5 \text{ J/kg}$$
$$= 3.36 \times 10^2 \text{ J/g}$$

Let, mass of ice formed $= mg$

Then,mass of water evaporated $= (100 - m)\, g$

As, no water is left in the vessel.

Heat gained by water in evaporation = Heat lost by water in freezing

$$(100 - m)\, L_1 = mL_2$$
$$(100 - m) \times 2.10 \times 10^3 = m \times 3.36 \times 10^2$$
$$m = 86.2 \text{ g}$$

If we write in terms of percentage, it will be 86.2%.

Thus (c) is correct option.

23. A liquid of mass 100 g at 120°C is poured in water at 20°C, when the final temperature recorded is 40°C. If the specific heat capacity of the liquid is 0.8 $Jg^{-1}\,°C^{-1}$, calculate the initial mass of water.

(a) 16.19 g (b) 56.19 g
(c) 36.19 g (d) 76.19 g

Ans : SQP 2004

Liquid $\theta = 40°C$ Water

$M = 100$ g

final temp. $m = ?$

$C_1 = 0.8$ $C_2 = 4.2$

$T = 120°C$ $t = 20°C$

Heat lost by liquid = Heat gained by water

$$MC_1(T - \theta) = mC_2(\theta - T)$$
$$100 \times \frac{8}{10}(120 - 40) = m\frac{42}{10}(40 - 20)$$
$$80 \times 80 = m\frac{42}{10} \times 20$$
$$84m = 6400$$

Hence, $m = \frac{6400}{84} = 76.19$ g

Thus (d) is correct option.

24. A waterfall is 1.5 km high. If the temperature of water at its top is 20°C find its temperature at the bottom of waterfall, assuming all the kinetic energy is converted into heat energy.

[Take $g = 10$ ms^{-2} and specific heat capacity of water = 4200 J Kg^{-1} c^{-1}]

(a) 13.57 °C (b) 33.57 °C
(c) 23.57 °C (d) 43.57 °C

Ans : MAIN 2008

Height of water fall = 1.5 km = 1500 m

Kinetic energy of falling water = Potential energy of water at top = mgh

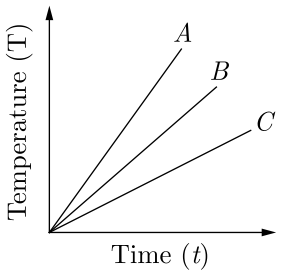
Hence, Potential energy = Kinetic energy = Heat produced in water

$$mgh = mC\Delta t$$
$$10 \times 1500 = 4200\,\Delta t$$
$$\Delta t = \frac{15000}{4200}$$
$$= \frac{150}{42} = \frac{25}{7} = 3.57°C$$
$$T - 20 = 3.57$$
$$T = 23.57°C$$

Thus (c) is correct option.

NODIA

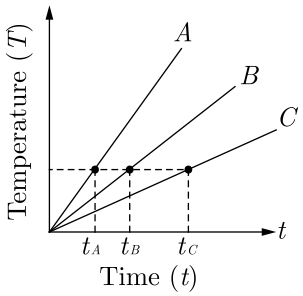
25. Which of the substance A, B and C has the lowest heat capacity, if heat is supplied to all of them at equal rates. The temperature versus time graph is shown.



(a) A
(b) C
(c) B
(d) All have equal specific heat

Ans : COMP 2017

Substances having more heat capacity take longer time to get heated to a higher temperature and longer time to get cooled.



If we draw a line parallel to time axis, then it cuts the given graphs at three different points corresponding points on the time axis, show that $t_C > t_B > t_A$.
$C_C > C_B > C_A$.
Thus (a) is correct option.

26. 50 g of a hot solid of specific heat capacity 0.25 $Jg^{-1}°C^{-1}$ and at 100°C is placed in 80 g of cold water, when the temperature of cold water rises by 3°C. Find the initial temperature of cold water.
(a) 6.36°C (b) 26.36°C
(c) 16.36°C (d) 36.36°C

Ans : MAIN 2023

$$m = 50 \text{ g},$$
$$C_s = 0.25$$
$$= \frac{25}{100} = \frac{1}{4}$$
$$T = 100^\circ\text{C}$$

Let θ be the final temp.
Hence, fall in temp. $= (100 - \theta)\,^\circ\text{C}$
Cold water at t °C.

$$m = 80 \text{ g}$$
$$C_w = 4.2 = \frac{42}{10}$$
$$\text{Rise in temp.} = \theta - t = 3$$

Heat lost by hot solid = Heat gained by water

$$MC_s(T - \theta) = mC_w(\theta - t)$$
$$50 \times \frac{1}{4}(100 - \theta) = 80 \times \frac{42}{10} \times 3$$
$$1250 - \frac{25}{2}\theta = 1008$$
$$\frac{25}{2}\theta = 1250 - 1008 = 242$$
$$\theta = 242 \times \frac{2}{25} = 19.36$$
$$\theta - t = 3$$
$$19.36 - t = 3$$
$$t = 19.36 - 3$$
$$= 16.36^\circ\text{C}$$

Thus (c) is correct option.

27. 1.6 kg of boiling water at 100°C is poured into 2 kg of crushed ice at [336×10^3 Jkg^{-1}] 0°C, such that final temperature recorded is 0°C. Calculate the specific heat of ice
(a) 36×10^3 Jkg^{-1} (b) 136×10^3 Jkg^{-1}
(c) 336×10^3 Jkg^{-1} (d) 236×10^3 Jkg^{-1}

Ans : SQP 2019

Let L Jkg^{-1} be the specific latent heat capacity of ice.

Heat gained by ice = Heat lost by boiling water

$$mL = mc_1\theta_R$$
$$2L = 1.6 \times 4200 \times 100$$
$$L = 336000$$

Hence, $L = 336 \times 10^3$ Jkg^{-1}
Thus (c) is correct option.

28. Heat energy is given to 100 g of water, such that its temperature rises by 10 K. When the same heat energy is given to a liquid L of mass 50 g its temperature rises by 50 K. Calculate (i) heat energy given to water, (ii) the specific heat capacity of liquid L.
Take specific heat capacity of water = 4200
(a) 1068 $J\,Kg^{-1}k^{-1}$ (b) 1086 $J\,Kg^{-1}k^{-1}$
(c) 1860 $J\,Kg^{-1}k^{-1}$ (d) 1680 $J\,Kg^{-1}k^{-1}$

Ans : MAIN 2001

Heat energy given to water

$$= mc\,\Delta t$$
$$= 100 \times 4.2 \times 10$$
$$= 4200 \text{ J}$$

Heat energy given to liquid L = 4200 J

$$mC\,\Delta t = 4200$$
$$50 \times C \times 50 = 4200$$
$$C = \frac{4200}{2500}$$
$$= 1.68 \text{ J kg}^{-1}\text{K}^{-1}$$
$$= 1.68 \times 1000$$
$$C = 1680 \text{ J Kg}^{-1}\text{ K}^{-1}$$

Thus (d) is correct option.

Click Here to Buy book on Amazon

29. A liquid of mass 100 g loses heat at a rate of 200 Js^{-1} for 1 minute. If the temperature of liquid drops by 100°C, Calculate the specific heat capacity of the liquid.

(a) 0.6 $Jg^{-1}\,°C^{-1}$ (b) 1.2 $Jg^{-1}\,°C^{-1}$

(c) 0.8 $Jg^{-1}\,°C^{-1}$ (d) 1.6 $Jg^{-1}\,°C^{-1}$

Ans : SQP 2021

$$\text{Mass of liquid } m = 100 \text{ g}$$

$$\text{Heat lost in 1 minute} = (200 \times 60) \text{ J}$$

$$\text{fall in temp. } \Delta t = 100°C$$

Hence, $mc\Delta t = H$

$$100 \times C \times 100 = 200 \times 60$$

$$C = \frac{200 \times 60}{100 \times 100}$$

$$= 1.2 \text{ Jg}^{-1}\,°C^{-1}$$

Thus (b) is correct option.

30. 3.75×10^5 calories of heat is given out by 5 kg of water at 100°C. Calculate the temperature of cooled water. Specific heat capacity of water is 1000 cal $kg^{-1}\,°C^{-1}$.

(a) 100°C (b) 75°C

(c) 90°C (d) 25°C

Ans : COMP 2003

$$H = 3.75 \times 10^5 \text{ calories}$$

$$m = 5 \text{ kg}$$

Let t be the temp. of cooled water

$$\text{fall in temp. } \Delta t = (100 - t)$$

$$C = 1000 \text{ cal kg}^{-1}\,°C^{-1}$$

$$mc\Delta t = H$$

$$5 \times 1000 \times (100 - T) = 3.75 \times 10^5$$

$$(100 - T) = \frac{375}{100} \times \frac{100000}{5 \times 1000}$$

$$= 75C$$

$$T = 100 - 75$$

$$= 25°C$$

Thus (d) is correct option.

31. A solid of mass 0.15 kg is heated from 10°C to 90°C. The specific heat capacity of the solid is 390 $Jkg^{-1}\,°C^{-1}$, find the heat absorbed by the solid.

(a) 6280 J (b) 5740 J

(c) 9850 J (d) 4680 J

Ans : MAIN 2012

Given, $m = 0.15 \text{ kg} = \frac{15}{100} \text{ kg}$;

$$C = 390 \text{ Jkg}^{-1}\,°C^{-1}$$

$$\text{Rise in temp. } \Delta t = 90 - 10$$

$$= 80°C$$

Hence, Heat absorbed by solid $= mc\Delta t$

$$= \frac{15}{100} \times 390 \times 80$$

$$= 4680 \text{ J}$$

Thus (d) is correct option.

32. If 1 g of steam is mixed with 1 g of ice, then the resultant temperature of the mixture is

(a) 270°C (b) 100°C

(c) 230°C (d) 50°C

Ans : COMP 2016

Heat required by 1 g ice at 0°C to mix with 1 g water at 0°C,

$$Q_1 = mL$$

Here, latent heat of fusion of ice,

$$L = 80 \text{ cal/g}$$

$$= 1 \times 80 = 80 \text{ cal}$$

Heat required by 1 g of water of 0°C to boil at 100°C,

$$Q_2 = mc\Delta T$$

Here, Specific heat of water,

$$c = 1 \text{ cal/g°C}$$

$$= 1 \times 1 \times (100 - 0)$$

$$= 100 \text{ cal}$$

Thus, total heat required by 1 g of ice to reach a temperature of 100°C,

$$Q = Q_1 + Q_2$$

$$= 80 + 100 = 180 \text{ cal}$$

Heat available with 1 g of steam to condense into 1 g of water at 100°C,

$$Q' = mL'$$

Here, latent heat of vaporisation,

$$L' = 536 \text{ cal/g}$$

$$= 1 \times 536$$

$$= 536 \text{ cal}$$

Obviously, the whole stream will not be condensed and ice will strain temperature of 100°C. Our of 536 cal, 80 cal used in fusion of ice, while remaining 456 cal will raise the temperature of mixture upto 100°C.

Thus (b) is correct option.

NODIA

33. Two bodies of specific heats c_1 and c_2 having same heat capacities are combined to form a single composite body. What is the specific heat of the composite body?

(a) $\frac{c_1 - c_2}{2c_1c_2}$ (b) $\frac{c_1 + c_2}{2c_1c_2}$

(c) $\frac{2c_1c_2}{c_1 - c_2}$ (d) $\frac{2c_1c_2}{c_1 + c_2}$

Ans : SQP 2020

As the heat capacities are equal, so

$$m_1 c_1 = m_2 c_2 \quad ...(i)$$

Where, m_1, m_2 are the masses of two bodies, c_1, c_2 are their specific heats.

Let c be the specific heat of the composite body.

Then, $(m_1 + m_2)\, c = m_1 c_1 + m_2 c_2$

$(m_1 + m_2)\, c = 2m_1 c_1$ [From eq. (i)]

$$c = \frac{2m_1 c_1}{m_1 + m_2}$$

$$= \frac{2m_1 c_1}{m_1 + m_2 \frac{c_1}{c_2}} = \frac{2c_1 c_2}{c_1 + c_2}$$

Thus (d) is correct option.

34. 272 calories of heat is required to heat 0.02 kg of a metal of specific heat capacity 170 cal $kg^{-1}\,°C^{-1}$ to a temperature T. If the initial temperature of the metal is 20°C, calculate the final temperature T.

(a) 25°C (b) 75°C

(c) 100°C (d) 90°C

Ans : COMP 2014

$H = 272$ calories

Mass of metal $= 0.02$ kg

$C = 170$ cal $kg^{-1}\,°C^{-1}$

Rise in temp. $\Delta t = (T - 20)$

$H = mc\Delta t$

$$272 = \frac{2}{100} \times 170\,(T - 20)$$

$$T - 20 = \frac{272 \times 10}{2 \times 17} = 80$$

$$T = 80 + 20 = 100°C$$

Thus (c) is correct option.

35. Water at 80°C is poured into a bucket containing 1.5 kg of crushed ice at 0°C, such that all the ice melts and the final temperature records is 0°C. Calculate the amount of hot water added to the ice.

[Take specific heat capacity of water 4200 J $g^{-1}\,°C^{-1}$ and specific latent heat of ice $= 336 \times 10^3$ J kg^{-1}]

(a) 0.5 kg (b) 3.5 kg

(c) 2.5 kg (d) 1.5 kg

Ans : SQP 2002

Let, mass of hot water $= x$ kg

Heat given get by hot water $= mc\Delta t$

$$= x \times 4200 \times (80 - 0)$$

Heat absorbed by ice to form water at 0°C $= mL$

Hence, $mL = x \times 4200 \times 80$

$$1.5 \times 336 \times 10^3 = x \times 4200 \times 80$$

$$x = \frac{15}{10} \times \frac{336000}{4200 \times 80}$$

$$= 1.5 \text{ kg}$$

Thus (d) is correct option.

36. A heater, rated 1000 W is used to heat 1.5 kg of water at 40°C to its boiling point. Calculate the time in which the water starts to boil. Specific heat capacity of water is 4200 J $kg^{-1}\,°C^{-1}$.

(a) 378 seconds (b) 225 seconds

(c) 480 seconds (d) 680 seconds

Ans : MAIN 2021

Let t be the time in seconds

Heat supplied $H = P \times t$

$$= (1000 \times t) \text{ J}$$

$m = 1.5$ kg

Rise in temp. $\Delta t = (100 - 40)$

$= 60°C$

$C = 4200$ $Jkg^{-1}\,°C^{-1}$

$H = mc\Delta t$

$$1000t = \frac{15}{10} \times 60 \times 4200$$

$$t = \frac{90 \times 4200}{1000}$$

$$= 378 \text{ seconds}$$

Thus (a) is correct option.

37. A liquid of mass 0.2 kg and temperature 135°C is cooled to 25°C. If the specific heat capacity of liquid is 750 $Jkg^{-1}\,°C^{-1}$, find the heat energy given out.

(a) 16500 J (b) 12000 J

(c) 8000 J (d) 20000 J

Ans : COMP 2005

Mass of liquid $m = 0.2$ kg

Fall in temp. $\Delta t = 135 - 25$

Downloaded from www.pdf.tube

2. The amount of heat energy required to melt a given mass of a substance at its melting point without any rise in its temperature is called as the:
(a) specific heat capacity
(b) specific latent heat of fusion
(c) latent heat of fusion
(d) specific latent heat of freezing

Ans : SQP 2025

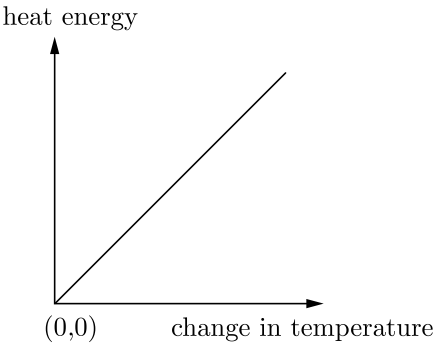
The amount of heat energy required to melt a given mass of a substance at its melting point without any rise in its temperature is called as the latent heat of fusion.
Thus (c) is correct option.

3. During melting of ice at 0°C the
(a) energy is released and temperature remains constant.
(b) energy is absorbed and temperature remains constant.
(c) energy is released and temperature decreases.
(d) energy is absorbed and temperature increases.

Ans : MAIN 2024

The latent heat of fusion causes energy to be absorbed during ice melting at 0°C, maintaining a constant temperature.
Thus (b) is correct option.

4. The graph given below shows heat energy supplied against change in temperature when no energy is lost to the surrounding. The slope of this graph will give



(a) Specific heat capacity
(b) Latent heat of fusion
(c) Latent heat of vaporization
(d) Heat capacity

Ans : MAIN 2024

Slope the graph gives the amount of heat required for unit rise of temperature. This is termed as the heat capacity.
Thus (d) is correct option.

5. The specific heat capacity of a substance
(a) changes with rise or fall in temperature.
(b) is a constant quantity for a given substance
(c) changes with the mass of given substance.
(d) changes with the area or volume of substance.

Ans : COMP 2016

The specific heat capacity of a substance is the amount of heat energy that is required to raise the temperature of the unit mass of a substance by unit degree. The specific heat capacity of different substances is different. Therefore it is constant for a given substance.
Thus (b) is correct option.

6. The specific heat capacity of water in S.I. system is
(a) 4.2 Jkg^{-1} K^{-1} (b) 4200 JKg^{-1} K^{-1}
(c) 42 JKg^{-1} K^{-1} (d) 420 JKg^{-1} K^{-1}

Ans : MAIN 2014

The specific heat capacity of a substance is the heat needed to raise the temperature of 1 Kg of the substance by 1° C. The specific heat capacity of water in SI system is 4200 $Jkg^{-1}K^{-1}$.
Thus (b) is correct option.

7. Land and sea breezes are formed in coastal regions because:
(a) land has very high specific heat capacity than the water.
(b) sea water cools the cooler regions.
(c) water has very high specific heat capacity than the land.
(d) all the above.

Ans : SQP 2013

The land and sea breezes are formed in coastal regions because water has a very high specific heat capacity than the land.
Thus (c) is correct option.

8. 4000 calories of heat energy is supplied to crushed ice at 0°C, such that it completely melts to form water at 0°C. If sp. latent heat of fusion of ice is 80 $cal\,g^{-1}$, what is the mass of ice ?
(a) 5 g (b) 25 g
(c) 50 g (d) 45 g

Ans : MAIN 2010

Heat required to melt ice = 4000 cal

$$mL = 4000$$

NODIA

capacity of turpentine oil.
[SHC for brass = 370 J Kg^{-1} k^{-1} ; SCH of copper = 390 J Kg^{-1} k^{-1})
(a) 1137.8 JKg^{-1} k^{-1} (b) 1731.8 JKg^{-1} k^{-1}
(c) 1371.8 JKg^{-1} k^{-1} (d) 1317.8 JKg^{-1} k^{-1}

Ans : MAIN 2002

θ = final temp. = 23°C

Heat lost by brass is given by

$$= mC_s (100 - 23)$$

$$m = \frac{200}{1000} \text{ kg}$$

$$= \frac{200}{1000} \times 370 \times 77$$

$$= 5698 \text{ J}$$

Heat gained by turpentine + calorimeter

$$= \left[\left(\frac{400}{1000} \times C_t\right) + \left(\frac{50}{1000} \times C\right)\right](23 - 15)$$

$$= \left(\frac{2}{5} C_t + \frac{1}{20} \times 390\right) \times 8$$

$$= \left(\frac{2}{5} C_t + \frac{39}{2}\right)8$$

$$= \left(\frac{16}{5} C_t + 156\right)\text{J}$$

Heat gained = Heat lost

$$\frac{16}{5} C_t + 156 = 5698$$

$$\frac{16}{5} C_t = 5698 - 156 = 5542$$

$$C_t = \frac{5542 \times 5}{16}$$

$$= 1731.8 \text{ } JKg^{-1}K^{-1}$$

Thus (b) is correct option.

43. Two identical calorimeters A and B contain equal quantity of water at 20°C. A 5 g piece of metal X of specific heat 0.2 cal g^{-1} °$(C)^{-1}$ is dropped into A and a 5 g piece of metal Y into B. The equilibrium temperature in A is 22°C and in B is 23°C. The initial temperature of both the metals is 40°C. Find the specific heat of metal Y in cal g^{-1} $(°C)^{-1}$.
(a) $\frac{27}{85}$ cal/g°C (b) 26 cal/g°C
(c) 27 cal/g°C (d) $\frac{85}{27}$ cal/g°C

Ans : SQP 2000

Given, A, B = calorimeters are identical in size. Quality of water is same in both the calorimeters = x

Temperature of water = 20°C

For metal X, mass = 5 g

Specific heat, c_1 = 0.2

Initial temperature = 40°C

Final temperature = 22°C

For metal Y, mass = 5 g

Specific heat, c_2 = c

Initial temperature = 40°C

Final temperature = 23°C

Now, for metal X,

Heat lost by X = heat gained by water

$$5 \times 0.2 \times (40 - 22) = x \times 1 \times (22 - 20)$$

$$5 \times 0.2 \times 18 = x \times 2$$

$$x = \frac{5 \times 0.2 \times 18}{2}$$

$$= \frac{5 \times 2 \times 18}{2 \times 10} = 9 \text{ g}$$

As, calorimeter B also contain equal of water i.e., 9 g.

Heat lost by metal Y = Heat gained by water

$$5 \times Y \times (40 - 23) = 9 \times 1 \times (23 - 20)$$

$$5 \times Y \times 17 = 9 \times 3$$

$$Y = \frac{9 \times 3}{5 \times 17}$$

$$= \frac{27}{85} \text{ cal/g°C}$$

Thus (a) is correct option.

44. A burner, supplies heat energy at a rate of 20 Js^{-1}. Find the specific heat capacity of a solid of mass 25 g, if its temperature rises by 80°C in one minute.
(a) 0.6 Jg^{-1} °C^{-1} (b) 1.6 Jg^{-1} °C^{-1}
(c) 0.8 Jg^{-1} °C^{-1} (d) 1.2 Jg^{-1} °C^{-1}

Ans : MAIN 2001

Heat supplied by burner in

1 minute $H = (60 \times 20)$ J

Mass of solid $m = 25$ g

Rise in temp. $\Delta t = 80°C$

$$mc\Delta t = H$$

$$25 \times c \times 80 = 1200$$

$$C = \frac{1200}{25 \times 80}$$

$$= \frac{3}{5} = 0.6 \text{ } Jg^{-1} °C^{-1}$$

Thus (a) is correct option.

Click Here to Buy book on Amazon

The two differences are :

	Specific heat capacity	Heat capacity
1.	Heat required to raise the temperature of a substance by 1 degree Celsius.	Heat required to raise the temperature of a unit mass of a substance by 1 degree Celsius
2.	Independent of mass of the substance.	Depends upon the mass of the substance.

93. Does land cool at a slower or faster rate than water? Give one reason for your answer.

Ans : SQP 2003

The land cools at a faster rate than water. This is because the specific heat capacity of water is more than that of land. For the same amount of heat lost, the fall in temperature of a given mass of land will, therefore, be more than that of an equal mass of water.

94. Explain why one feels ice-cream at 0°C colder than water at 0°C.

Ans : SQP 2001

Ice-cream draws latent heat of fusion for its melting which water does not draw. To melt, ice-cream needs latent heat of fusion, which is higher than the specific heat of water.

95. (i) Name the material used for making a Calorimeter.
(ii) Why is a Calorimeter made-up of thin sheets of the above material answered in (i)?

Ans : COMP 2019

(i) Copper.
(ii) Copper has small specific heat capacity. The thin sheets ensure that the box has small heat capacity.

96. Why does a bottle of soft drink cool faster when surrounded by ice cubes than by ice cold water, both at 0°C?

Ans : MAIN 2013

Although both ice cubes and water are at 0 °C but ice cubes cool better because each gram of ice requires additional 80 calories of heat to get converted into water at the same temperature, i.e. at 0 °C. Hence, the cooling capacity of ice cubes is more than that of ice water.

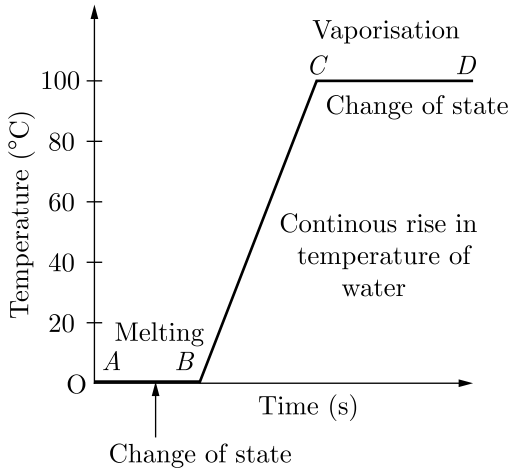
97. Why does a hot cup of tea get cooled on adding sugar to it?

Ans : SQP 2001

Hot cup of tea gets cooled on adding sugar to it because sugar takes heat (latent heat of fusion) from the tea and changes its state from solid to liquid.

98. Some ice is heated at a constant rate, and its temperature is recorded after every few seconds, till steam is formed at 100°C. Draw a temperature time graph to represent the change. Label the two phase changes in your graph.

Ans : COMP 2016



99. Differentiate between heat and temperature.

Ans : COMP 2011

	Heat	Temperature
(i)	Heat is the energy of transit.	Temperature is the fundamental quantity which determines the direction of flow of heat.
(ii)	Its S.I. unit is Joule.	Its S.I. unit is Kelvin.

100. What energy change would you expect to take place in the molecules of a substance when it undergoes :
(1) a change in its temperature ?
(2) a change in its state without any change in its temperature ?

Ans : SQP 2010

NODIA

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!

Ans :

37°C is considered as the normal human body temperature. It is the average body temperature of a large number of healthy persons however, it could be slightly higher or slightly lower.

50. **Assertion :** The specific heat capacity of a given solid can be determined by using the principle of calorimetry
Reason : Heat gained is equal to the heat lost.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are True and reason is not the correct explanation of assertion.
(c) Assertion is false but reason is true.
(d) Assertion is true but reason is false.

Ans :

Calorimetry means measurement of heat, the heat lost by the body is equal to the gained by the cold body provided no heat is allowed to escape to the surrounding.

ONE MARK QUESTIONS

51. Define Calorimetry.

Ans : COMP 2019

Calorimetry is the measurement of heat.

52. Name the physical quantity which is measured in calories.

Ans : SQP 2019

Heat energy.

53. How is calorie related to the SI unit of that quantity?

Ans : COMP 2019

1 cal = 4.2 J.

54. Define heat capacity of a substance.

Ans : MAIN 2020

Specific heat (c) of a material is defined as the amount of heat required in raising the temperature of a unit mass of a substance through 1 °C or 1 K.

55. Write the SI unit of heat capacity.

Ans : SQP 2020

In SI, unit of heat capacity is J K^{-1}.

56. Which property of water makes it an effective coolant?

Ans : COMP 2015

High specific heat capacity of water makes it an effective coolant.

57. State the effect of an increase of impurities on the melting point of ice.

Ans : MAIN 2015

Increase of impurities, decreases the melting point of ice.

58. Define Calorimetry.

Ans : SQP 2011

A calorimetry is the phenomenon through which we measure the amount of heat gained or lost by a body when it is mixed with other body.

59. What is meant by Energy degradation?

Ans : COMP 2011

It is the transformation of energy into some form in which it is less available for doing work.

60. How can a temperature in degree Celsius be converted into SI unit of temperature?

Ans : COMP 2018

1°C = 273 K

61. A liquid X has the maximum specific heat capacity and is used as a coolant in Car radiators. Name the liquid X.

Ans : SQP 2018

Water.

62. Heat supplied to a solid change it into liquid. What is this change in phase called ?

Ans : COMP 2018

Melting.

63. During the phase change does the average kinetic energy of the molecules of the substance increase?

Ans : SQP 2018

Yes.

64. What is the energy absorbed during the phase change called?

Ans : COMP 2018

Heat of fusion.

NODIA

Aluminium is best suited for measurement of the temperature of a furnace because amongst metals aluminium has the highest specific heat capacity ($c = 900\ \text{J kg}^{-1}\ \text{K}^{-1}$) due to which it will transfer more heat than other metals for the same mass and temperature change.

112. Why do the surroundings become pleasantly warm when freezing starts in cold countries?

Ans : SQP 2006

In cold countries, when freezing of water starts, it gives out its heat in the process of cooling up to 0°C. This heat makes the surrounding atmosphere less cold or pleasantly warmer.

113. What is wrong with the statement, body at higher temperature contains more heat?

Ans : COMP 2017

Heat is the energy in transit so a body cannot contain heat. Actually body at higher temperature contains more internal energy.

114. In what way will the temperature of water at the bottom of a waterfall be different from the temperature at the top? Give a reason for your answer.

Ans : MAIN 2017

Temperature at the bottom of a waterfall is slightly higher than that at the top because some potential energy of the water changes to heat energy.

115. Why do wet clothes dry quicker in the sun than in the shade?

Ans : MAIN 2011

Evaporation depends upon temperature. It is more for higher temperatures. The temperature in sunny portions is higher than that in the shade. As a result, wet clothes dry quicker in the sun than in the shade.

116. What is the effect of increase in pressure on the melting point of ice and boiling point of water?

Ans : SQP 2010

(i) Melting point of ice decreases with an increase in the pressure.
(ii) Boiling point of water increases with an increase in the pressure.

117. Why do you generally catch cold if you put on wet clothes for a long time?

Ans : COMP 2002

If we wear wet clothes for a long time, it may cause over-cooling of the body due to rapid evaporation of water. Water, while evaporating, takes latent heat from the body thus, lowers the resistance of the body to cold.

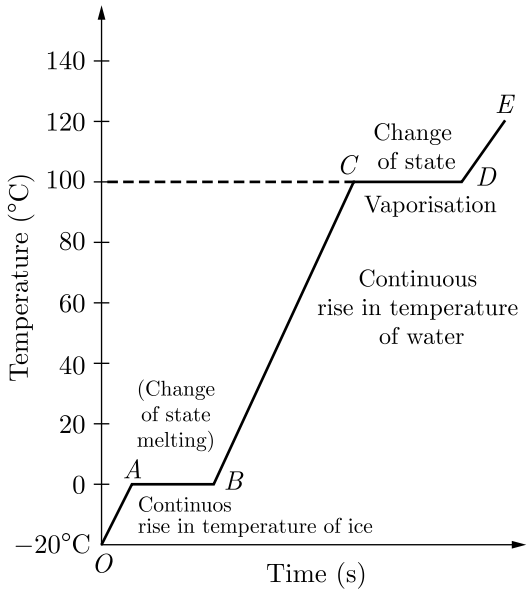
118. Why does temperature of a substance remain constant during melting and vaporisation even when heat is being supplied to it continuously?

Ans : SQP 2002

This is because the heat supplied to the substance is used up in overcoming the intermolecular forces (change of state) and, therefore, it does not show up as an increase in temperature. Since this heat remains hidden, therefore, it is called latent heat. It is used to raise the potential energy of the molecules and not the kinetic energy.

119. A slab of ice at -20°C is constantly heated till the steam attains a temperature of 120°C. Draw a graph showing the change of temperature with time label the various parts of the graph.

Ans : MAIN 2013



120. In winter, the weather forecast for a certain day was 'severe frost'. A wise farmer watered his fields the night before to prevent frost damage to his crops. Why did he water his fields?

or

Why do the farmers leave their fields flooded?

Ans : MAIN 2002

Downloaded from www.pdf.tube

High specific heat capacity of water is used in hot water bottles for fomentation.

81. Give one example where high specific heat capacity of water is used for cooling purposes.

Ans : COMP 2020

High specific heat capacity of water is used for cooling radiators in cars.

TWO MARKS QUESTIONS

82. Water freezes to form ice. What change would you expect in the average kinetic energy of the molecules?

Ans : MAIN 2024

Since there is no change of temperature there is no change in kinetic energy.

83. Why does a stone lying in the sun get heated up much more than water lying for the same duration of time?

Ans : COMP 2020

Because water has a large specific heat while stone has a small specific heat.

84. Water in lakes and ponds do not freeze at once in cold countries. Give a reason in support of your answer.

Ans : MAIN 2015

Water in lakes and ponds do not freeze at once in cold countries because of high specific latent heat of fusion of ice ($336\ Jg^{-1}$). It means to freeze water, a large quantity of heat has to be withdrawn from the water, hence water freezes slowly.

85. The specific heat capacity of a substance A is $3800\ Jkg^{-1}K^{-1}$ and that of a substance B is $400\ J\ kg^{-1}K^{-1}$. Which of the two substances is a good conductor of heat? Give a reason for your answer.

Ans : SQP 2019

Substance B, Because it requires relatively little heat to raise its temperature.

86. State two factors upon which the heat absorbed by a body depends.

Ans : COMP 2016

Heat absorbed by a body depends upon the mass of the body and rise in its temperature.

87. (i) What is the principle of Calorimetry?
(ii) Name the law on which this principle is based.

Ans : MAIN 2015

(i) According to the principle of calorimetry, for a fully insulated system, heat energy lost by the hot body = heat energy gained by the cold body.
(ii) Principle of calorimetry is based on the law of conservation of energy.

88. Rishi is surprised when he sees water boiling at 115° C in a container. Give reasons as to why water can boil at the above temperature.

Ans : MAIN 2015

The boiling point of water depends upon the pressure at which it is boiled. Higher the pressure, higher is the boiling point of water.

89. Define the term 'Heat capacity' and state its S.I. unit.

Ans : MAIN 2013

Heat capacity of a body is defined as the amount of heat required to change its temperature by 1 K. Its SI unit is JK^{-1}.

90. (a) Which material is the calorimeter commonly made of?
(b) Give one reason for using this material.

Ans : SQP 2010

(a) Copper
(b) Copper is used because it has a very low heat capacity.

91. Which of the two, 1 g of ice at 0°C or 1 g of water at 0°C contains more heat? Give reason for your answer.

Ans : COMP 2004

At 0°C, is more than that contained in 1 g of ice at 0°C.
This is because 1 g of water at 0°C, when converted into 1 g of ice at 0°C, will release about 336 J of heat. It therefore, contains about 336 J of heat more than 1 g of ice at 0°C.

92. State two differences between "Heat Capacity" and "Specific Heat Capacity".

Ans : MAIN 2018

NODIA

cool. During summer, when the temperature is high, a plant must transpire more to keep itself cool. More transpiration requires more leaves. So, plants acquire more leaves during summers.

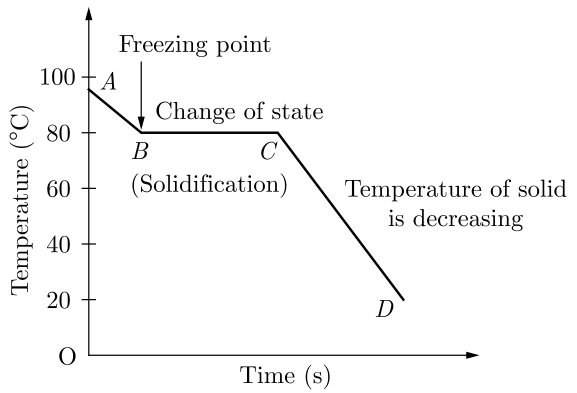
130. Which contains more heat; 1 g water at 100 °C or 1 g steam at 100 °C? Give reason.

Ans : COMP 2009

1 g steam at 100 °C contains more heat than 1 g water at 100 °C. The reason is that when 1 g steam at 100 °C converts to 1 g water at 100°C, liberates 2268 J heat. 1 g of steam has 2268 J of additional heat in the form of latent heat which 1 g of water at the same temperature does not have.

131. The melting point of naphthalene, a crystalline solid is 80°C and the room temperature is 20°C. Liquid naphthalene at 90°C is cooled to room temperature. Draw the temperature-time graph to represent this cooling.

Ans : COMP 2020



132. Distinguish between evaporation and boiling.

Ans : SQP 2020

	Evaporation	**Boiling**
1.	It is a slow process.	It is a rapid process.
2.	It takes place at the surface of liquid.	It takes place throughout the mass of liquid.

133. Discuss the role of high specific heat of water with reference to the climate in coastal area.

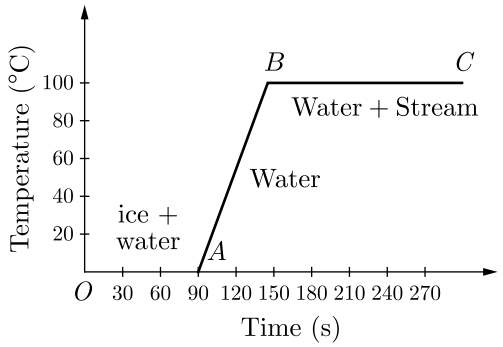
Ans : COMP 2020

The specific heat capacity of water is very high i.e., 4200 J $kg^{-1}°C^{-1}$. It is about 5 times as high as that of sand. So water takes a very long time to get heated up and an equally long time to get cooled. Thus, there is a large difference in temperature between the land and the sea due to which land and sea breezes are formed.

134. 1 kg of ice is heated at a constant rate and its temperature is recorded after every 30 second till steam is formed at 100 °C. Draw the temperature-time graph to represent the change.

Ans : MAIN 2014

The temperature-time graph is as shown :



135. How do the wine/juice bottles under water, remain safe against freezing in very cold countries?

Ans : SQP 2002

In cold countries, wine/juice bottles are placed under water to prevent freezing because water has to release large amount of heat (4.2 J for each gram of water) to lower its temperature to the same extent as juice and hence the chances of freezing are reduced.

136. Why are hot water bottles very efficient for fomentation?

Ans : SQP 2002

Fomentation is heating the swollen parts of the body at moderate temperature at about 50 °C as it brings a lot of relief. We use hot water bottles for fomentation purposes, because water can store in it a large amount of heat energy at fairly low temperature, owing to its high specific heat capacity.

137. A strong sensation of cooling is produced when a little methylated spirit is applied on the hand. Explain why. Suggest one way by which the cooling sensation may be increased.

Ans : COMP 2021

Click Here to Buy book on Amazon

(1) The energy of the molecules of a body increases with the rise in temperature and decreases with the fall of temperature.
(2) Since temperature remains constant there is no change in the kinetic energy of the molecules. The energy given to substance to change the state of the substance increases potential energy of the molecules

101. A certain amount of heat Q will warm 1 g of material X by 3°C and 1 g of material Y by 4°C. Which material has a higher specific heat capacity?

Ans : MAIN 2013

Specific heat capacity $C = \frac{Q}{m\Delta T}$

For the same mass of the material and same amount of heat $C \propto \frac{1}{\Delta T}$

Thus, smaller is the change in temperature more is the specific heat capacity. Therefore, for 3°C change in temperature of material X, specific heat capacity will be more.

102. Why do we feel relief under a fan when we are perspiring?

Ans : SQP 2013

The air from the fan causes rapid evaporation of sweat. During evaporation, the sweat takes away heat from the body. As a result, we feel relief from the heat.

103. Why is there year long supply of water in snow fed rivers?

Ans : COMP 2002

In summer, the snow melts slowly on the mountains because every kilogram of snow requires 336000 J of heat energy in order to form water at 0°C. Thus, there is year long supply of water in snow fed rivers.

104. Define specific latent heat of vaporisation.

Ans : COMP 2002

The specific latent heat of vaporisation of a given liquid is defined as the heat required to convert one kilogram of the liquid into vapour, at its boiling point, without any change in its temperature.

105. Which extinguishes a fire more quickly, hot water or cold water?

Ans : SQP 2000

Hot water, It being at higher temperature is converted into steam in lesser time, thereby stopping combustion by extinguishing the fire.

106. Why does the temperature of the surroundings start falling when the ice of a frozen lake starts melting?

Ans : MAIN 2010

When the ice of a frozen lake starts melting, it takes latent heat of fusion from the surroundings. Therefore, the temperature of the surroundings start falling.

107. What do you understand by the specific latent heat of fusion of a substance?

Ans : SQP 2000

The specific latent heat of fusion of a given solid is the heat required to melt one kilogram of it at its melting point without change of temperature. It is measured in $J\text{kg}^{-1}$.

108. Why does heat in summer get very oppressive just after rainfall?

Ans : COMP 2001

Heat in summer gets oppressive specially just after rainfall because air is almost completely saturated with water vapour. Due to which evaporation of sweat from our body almost stops and thereby body stops losing heat.

NODIA

109. Why does the air passing through a desert cooler become cooler?

Ans : SQP 2001

In a desert cooler, hot and dry air passes through wet pads of wood-wool. Water takes heat from the hot air and evaporates. The evaporation of water cools the pads and the circulating water. As a result, the incoming air also gets cooled.

110. Explain why the base of a cooking pan is made thick.

Ans : COMP 2006

When we make the base thick, the capacity of cooking pass, its thermal capacity increases. Thus, it can impart sufficient energy for cooking even at a low temperature.

111. Why is aluminium best suited for measurement of temperature of a furnace?

Ans : COMP 2006

65. Give a mathematical relation between Heat Capacity and Specific Heat Capacity.

Ans : MAIN 2018

Heat capacity = specific heat × mass of substance.

66. Define the term 'specific latent heat of fusion' of a substance.

Ans : COMP 2010

It is defined as the amount of heat required to melt one kilogram of a substance at its melting point without any change in temperature.

67. Name the liquid which has the highest specific heat capacity.

Ans : SQP 2010

Water has the highest specific heat capacity.

68. Name two factors on which the heat absorbed or given out by a body depends?

Ans : COMP 2010

The heat absorbed or given out by a substance depends upon (1) mass of the body. (2) rise or fall of temperature.

69. Which material is the calorimeter commonly made of ?

Ans : COMP 2016

Calorimeter is usually made of copper.

70. Why does one feel cold after a bath?

Ans : SQP 2011

After a bath, the water left on our body evaporates and during evaporation it takes heat from our body, so we feel cold.

71. The specific latent heat of fusion of ice is 336 jg^{-1} . Comment on this statement.

Ans : SQP 2011

The heat required to convert 1 g of ice at 0°C to 1 g water at 0°C is 336 J.

72. In summer, dogs hang out their tongues. Explain why?

Ans : COMP 2009

Dogs do not sweat. They hang out their tongues during summer day. Evaporation from the tongue takes place which gives a sensation of cooling to the dog.

73. Why do the exposed water pipes burst during a severe frost?

Ans : SQP 2011

Exposed water pipes burst during a severe frost because of expansion of water in the pipes on freezing.

74. Why do we feel cool after hot water bath?

Ans : COMP 2009

We feel cool after hot water bath because water being at higher temperature, rate of evaporation becomes fast, thereby giving a sensation of cooling.

75. Write the approximate value of the specific latent heat of fusion of ice.

Ans : MAIN 2009

The specific latent heat of fusion of ice is 336000 Jkg^{-1}.

76. Comment on the use of water as a coolant.

Ans : MAIN 2008

Since water has a high value of specific heat capacity $(4200\,J\,kg^{-1}\,K^{-1})$. Therefore, it can be used as a coolant.

77. Why does evaporation always produce cooling?

Ans : SQP 2019

Evaporation always produces cooling as some heat is required to evaporate the liquid. This heat is taken from surroundings and thus surroundings get cooled.

78. Why do icebergs sometimes reach the equatorial regions?

Ans : SQP 2020

Because of high specific latent heat of fusion of ice, the icebergs sometimes reach the equatorial regions by the ocean currents.

79. When 1 g of ice at 0 °C melts to form 1 g of water at 0 °C then, is the latent heat absorbed by the ice or given out by it ?

Ans : SQP 2020

Latent heat is absorbed by ice.

80. Give one example where high specific heat capacity of water is used as a heat reservoir.

Ans : COMP 2020

Downloaded from www.pdf.tube

Farmers fill their fields with water to protect the crops from frost. It is because water has highest specific heat capacity. Thus, every 1 g of water liberates 4.2 J of heat for 1°C fall of temperature, i.e. cooling water liberates large amount of energy which does not allow the temperature of field to fall below 0°C.

121. Doctors advise to put strips of wet cloth on the forehead of a person having high temperature (fever). Why ?

Ans : COMP 2002

Doctors advise to put strips of wet cloth on the forehead of a person having high temperature (fever). The reason is that the water while evaporation takes away the necessary heat from the body of the patient and thus, lowers the temperature of his body. Ice for melting will require a large amount of heat from forehead leading to shrinkage of capillaries.

122. Explain why bottled soft drinks are more effectively cooled by cubes of ice than by ice water.

Ans : SQP 2023

Although both ice cubes and water are at 0°C but ice cubes cool better because each gram of ice requires additional 80 calories of heat to get converted into water at the same temperature, i.e. at 0°C. Hence the cooling capacity of ice cubes is more than that of ice water.

123. The temperature recorded by a thermometer decreases when its bulb is covered with a piece of cloth soaked in spirit. Explain why.

Ans : SQP 2023

To get evaporated, spirit requires latent heat of vaporisation to convert itself to vapour. It takes heat from the surroundings including mercury in the bulb of thermometer. Thus, temperature recorded by thermometer decreases.

124. Why do pieces of ice added to a drink cool it much faster than ice cold water added to it?

Ans : COMP 2013

Ice-cubes and ice cold water, both are at the same temperature but ice-cubes cool a drink effectively because each gram of ice-cubes will absorb 336 J additional heat from the drink in the form of latent heat while the same mass of ice cold water at the same temperature will not absorb. Therefore, ice-cubes cool a drink effectively.

125. Give one example each where high specific heat capacity of water is used:
(a) in cooling,
(b) as heat reservoir.

Ans : COMP 2019

(a) Water is used as a coolant to remove heat in automobile/generator radiator because a large amount of heat energy ($Q \propto c$) is removed by circulating water without any appreciable change in its own temperature.
(b) Water is used as heat reservoir in boilers used in central heating system in cold countries.

126. Discuss the role of high specific heat of water with reference to the climate in coastal area.

Ans : COMP 2019

The specific heat capacity of water ($4200\ \text{J kg}^{-1}\ \text{K}^{-1}$) is nearly 5 times high as that of sand. Due to which water takes long time to get heated up and equally long time to get cooled. Thus, large temperature difference between the land and the sea causes the formation of land and sea breezes.

127. Explain how does the volume of ice change when it is heated from 0°C to 10°C.

Ans : SQP 2017

When ice melts at 0°C on heating, its volume decreases and converts into water at 0°C. Now, as water at 0°C is heated further it starts contracting till it has its minimum volume at 4°C. Thereafter, on heating, the volume of water begins to increase.

128. Why does a stone lying in the sun get heated up very much, whereas water lying in the sun for the same duration gets heated very little?

Ans : MAIN 2017

Water has the specific heat capacity $C = 4200\ \text{J/kg K}$ which is about 5 times the specific heat capacity of the stone. So when the sun shines, water heats up very slowly whereas the stone heats up very fast. That is why the stone gets heated up very much as compared to the water.

129. Why do plants acquire more leaves during summer?

Ans : COMP 2017

Evaporation of water from the leaves is called transpiration. Transpiration helps plants to keep

NODIA

ASSERTION AND REASON

45. **Assertion :** Heat energy is transferred from one body to another due to a temperature difference between them.
Reason : Heating a substance causes a rise in temperature.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are True and reason is not the correct explanation of assertion.
(c) Assertion is false but reason is true.
(d) Assertion is true but reason is false.

Ans :

Heat energy always travels from hotter object to colder objects.
Thus option (b) is correct.

46. **Assertion :** The specific heat capacity of a substance is the amount of heat required to raise its temperature by 1°C.
Reason : The specific heat capacity of a substance is not its characteristic property.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are True and reason is not the correct explanation of assertion.
(c) Assertion is false but reason is true.
(d) Assertion is true but reason is false.

Ans :

The specific heat capacity of a substance is the amount of heat required to raise the temperature of one unit mass of the substance by 1°C.

The specific heat capacity of a substance is its characteristic property. It represents the substance's ability to store heat energy per unit mass and is an intrinsic property that is unique to each substance.

47. **Assertion :** The principle of the method of mixtures involves mixing substances at different temperatures to find the final temperature.
Reason : The law of conservation of energy states that the energy is neither created nor destroyed in an isolated system.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are True and reason is not the correct explanation of assertion.
(c) Assertion is false but reason is true.
(d) Assertion is true but reason is false.

Ans :

The principle of the method of mixtures involves mixing substances at different temperatures to find the final temperature. This method is based on the principle that heat lost by the hotter substance is equal to the heat gained by the colder substance when they reach thermal equilibrium.

The law of conservation of energy states that energy is neither created nor destroyed in an isolated system. This principle is fundamental in understanding heat transfer processes, including the method of mixtures. In the method of mixtures, the total energy of the system (the substances being mixed) remains constant, as energy is transferred from the hotter substance to the colder substance until thermal equilibrium is reached.

48. **Assertion :** According to the principle of calorimetry: Heat gained by a cold body = Heat lost by a hot body.
Reason : Heat is a form of energy, so according to the law of conservation of energy, the energy cannot be created or destroyed and its sum total remains the same.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are True and reason is not the correct explanation of assertion.
(c) Assertion is false but reason is true.
(d) Assertion is true but reason is false.

Ans :

Heat flows from a hot body to the surrounding cool bodies until all the bodies attain thermal equilibrium. So,
The heat lost by a hot body = the heat gained by the cold body.
The whole energy in this universe is conserved.
It can neither be created nor destroyed. Energy flows from one body to another. Heat is a form of energy that flows from the hot bodies to the cold bodies.

49. **Assertion :** The body temperature of every person is not 370C
Reason : It is an average temperature of human body.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are True and reason is not the correct explanation of assertion.
(c) Assertion is false but reason is true.
(d) Assertion is true but reason is false.

Click Here to Buy book on Amazon

Methylated spirit, being highly volatile, draws away latent heat from the hand for its evaporation, producing a cooling sensation. It can be increased by blowing air over it.

138. Damp khus-khus screens are used to cool air in the room in dry hot summer. Explain why.

Ans : SQP 2007

Damp khus-khus screens are used to cool air in the room in hot dry summer because water from the khus-khus evaporates by taking latent heat of vaporisation from the air entering into the room. Thereby, the temperature of the air of the room falls or the air of the room gets cooled.

139. Is it possibly to condense the water formed, back to ice by adding ice at 0°C? Explain, giving a suitable reason to justify your answer.

Ans : COMP 2016

No, If ice at 0°C is added to the water formed from the ice, it will not freeze. Because freezing of water depends on removal of latent heat (i.e. 336 J/g) from the water. Since both the ice added and water formed are at 0°C each, there can be no transfer of heat from water to the ice added. So, the ice added will just keep on floating in the water with the temperature remaining at 0°C.

140. Define the terms :
(i) Heat capacity and
(ii) Specific heat capacity.

Ans : COMP 2014

(i) **Heat capacity :** The heat capacity of a body is the amount of heat required to raise its temperature by 1°C. Its unit is $J°C^{-1}$.
(ii) **Specific heat capacity :** The specific heat capacity of a substance is the amount of heat required to raise the temperature of unit mass of that substance through 1°C. Its unit is $Jkg^{-1}\ °C^{-1}$.

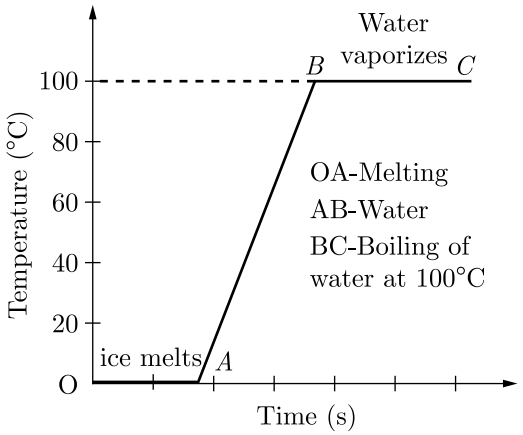
141. Why does water get cooled in an earthen pot ?

Ans : COMP 2014

An earthen pot has small pores in its walls. When water is poured into it, some of its seeps through these pores onto its outer surface. On reaching there, it evaporates. The heat required for evaporation is taken from the earthen pot and from the water in it. As a result, the water in an earthen pot gets cooled down.

142. A certain quantity of ice at 0°C is heated till it changes into steam at 100°C. Draw a time-temperature heating curve to represent it. Label the two phase changes in your graph.

Ans : MAIN 2014



143. Why does a location closed to water reservoir affect the air temperature?

Ans : SQP 2000

Place close to large water reservoirs is not so hot in summer than in those far away from water reservoirs because water due to its large specific heat capacity absorbs a large quantity of heat. Similarly, in winter, the water body cools down and gives off large quantity of heat and therefore, it is not so cold in winter in such places.

144. How can you reduce the heat loss due to conduction and convection, in a calorimeter?

Ans : SQP 2000

To reduce heat losses by conduction and convection to the surrounding air, the calorimeter is placed in a larger container of insulating material such as wood and the gap in between calorimeter and wooden box is filled by an insulating material such as cotton waste or wool, etc.

145. What do you mean by the term relegation? State its one consequence.

Ans : COMP 2000

Relegation is the phenomenon due to which ice at 0°C melts to form water at a temperature below 0°C on the application of external pressure and the refreezing of water so formed into ice on the release of pressure, e.g. Glaciers in cold countries or on high mountains.

Downloaded from www.pdf.tube

attain the same temperature, i.e. heat lost by the hot body is equal to the heat gained by the cold body provided there is no heat loss to the surroundings.

(ii) Law of conservation of energy.

172. Can the specific heat of a substance be (a) zero, (b) infinite?

Ans : COMP 2002

(a) Yes, as

$$c = \frac{Q}{m\Delta T}$$

For $c = 0$ either $Q = 0$ or $\Delta T = \infty$. But as ΔT cannot be ∞ only $Q = 0$, i.e. during compression of a gas or shaking of a liquid $\Delta T \neq \infty$ but heat given to the system Q may be, so c will be zero.

(b) Yes. For $c = \infty$ either $Q = \infty$ or $\Delta T = 0$. But as $Q \neq \infty$, ΔT can be zero so c will be infinite, e.g. during melting of a solid or boiling of a liquid $\Delta T \neq \infty$, but $\Delta T = 0$. Therefore, $c = \infty$.

173. How does a desert cooler lower the temperature? Why is it not effective after the monsoon sets in?

Ans : COMP 2002

Desert cooler used in hot dry climate, works on the cooling produced by evaporation. A pump forces water to trickle through filters fitted on the three sides of a cubic metal box. A fan draws air from outside through the filters (water-soaked) and sends into the room. Forced evaporation of water produces cooling. But as the rain starts, it becomes ineffective because the air becomes humid and saturated with water vapour. So, evaporation does not take place and hence, cooling is not produced.

174. A certain amount of heat Q will warm 1 g of material X by 3°C and 1 g of material Y by 4°C. Which material has the greater specific heat?

Ans : COMP 2017

Specific heat capacity,

$$c = \frac{Q}{m\Delta T}$$

For the same mass of the material and same amount of heat $c \propto \frac{1}{\Delta T}$

Thus, smaller is the change in temperature more is the specific heat. Therefore, for 3°C change in temperature of material X, specific heat capacity will be more.

175. List three differences between boiling and evaporation.

Ans : SQP 2017

Difference between boiling and evaporation are as follows:

	Boiling	**Evaporation**
(i)	It takes place at a definite temperature fixed for a given liquid (depending upon the pressure), by directly heating the liquid.	It takes place at all temperatures without heating the liquid directly.
(ii)	It is a rapid process.	It is a slow process.
(iii)	It takes place only when the pressure of the liquid vapour on the surface of the liquid is equal to the atmospheric pressure on it.	It takes place at all pressures.

NODIA

176. Why does the water remain cool in hot summer but not in rainy season in earthen pitchers?

Ans :

In earthen pitchers, water remains cool in hot summer because water oozes out from the pores of pitcher. It evaporates partly taking heat from the water within the pitcher and the water in the pitcher loses heat and becomes cool.

But in the rainy season, saturated air with water vapour slows down the rate of evaporation to a great extent. Thus, the water within the pitcher does not lose heat and hence it does not keep cool.

177. Two bodies have the same heat capacity. If they are combined to form a single composite body, show that the equivalent specific heat of this composite body is independent of the masses of the individual bodies.

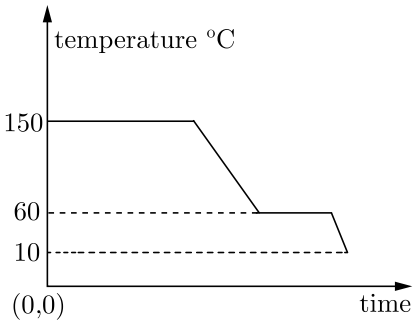
Ans : MAIN 2017

Let masses of two bodies be m_1 and m_2 and specific heat c_1 and c_2. Then

$$m_1 c_1 = m_2 c_2$$

or

$$\frac{m_1}{m_2} = \frac{c_2}{c_1}$$



(c) Why do we prefer ice to ice-cold water for cooling a drink?

Ans : SQP 2025

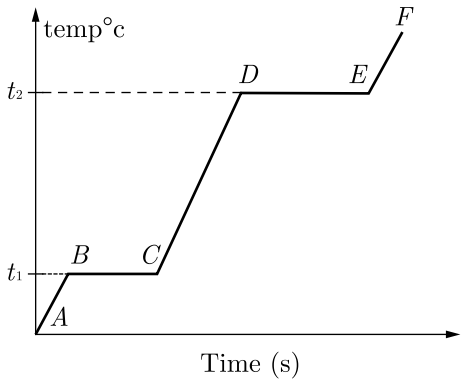
(a) 150°C -
(b) 150°C to 60°C
(c) Every gram of ice can absorb 336 J heat more than ice-cold water due to its high specific latent heat.

155. Which will contain more heat energy 1 g of ice at 0°C or 1 g water at 0°C?

Ans : MAIN 2024

1 g of ice (solid) at 1°C has extra heat in the form of its Latent Heat while 1 g of water (liquid) at loC has no Latent heat.
Hence, heat energy in 1 g of ice at 0°C has more heat energy than the 1 g water at 0°C.

156. The diagram below shows the change of phases of a substance on a temperature vs time graph on heating the substance at a constant rate.
(i) Why is the slope of CD less than slope of AB?
(ii) What is the boiling and melting point of the substance ?



Ans : SQP 2020

(i) From section CD, the specific heat is high as compared to section AB.
(ii) t_2 and t_1 respectively.

157. (i) State whether the specific heat capacity of a substance remains the same when its state changes from solid to liquid.
(ii) Give one example to support your answer.

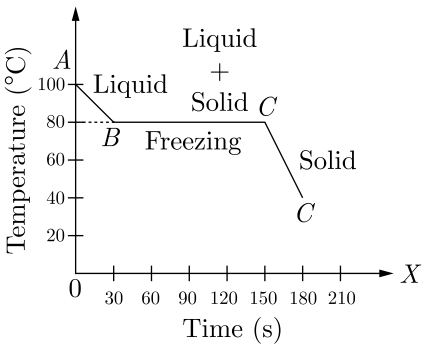
Ans : MAIN 2019

(i) No, specific heat capacity does not remain the same when it changes from solid to liquid.
(ii) Let us take the example of water.
Specific heat capacity of water
$$= 4.2\ \text{J kg}^{-1}K^{-1}$$
and specific heat capacity of ice
$$= 2.1\ \text{J kg}^{-1}K^{-1}$$

158. The melting point of naphthalene is 80°C and the room temperature is 30°C. A sample of liquid naphthalene at 100°C is cooled down to the room temperature. Draw a temperature-time graph to represent this cooling. In the graph, mark the region which corresponds to the freezing process.

Ans :

The graph is as shown



159. Specific heat capacity of substance A is $3.8\ \text{J g}^{-1}\text{K}^{-1}$ whereas the specific heat capacity of substance B is $0.4\ \text{J g}^{-1}\text{K}^{-1}$.
(i) Which of the two is a good conductor of heat?
(ii) How is one led to the above conclusion?
(iii) If substances A and B are liquids, then which one would be more useful in car radiators?

Ans : SQP 2014

(i) Substance B is a good conductor out of the two substances.
(ii) The specific heat capacity of B is lower than A. This means that less heat is required to raise the temperature of 1 g of B by 1 K than the heat required for A.
(iii) If both substances were liquids, then substance

Click Here to Buy book on Amazon

By principle of mixtures

$$\text{Heat lost} = \text{heat gained}$$

$$(\text{m} \times \text{c} \times \Delta\text{T})_{\text{metal}} = (\text{m c } \Delta\text{T})_{\text{water}}$$

$$\text{c'} \times 75 = 150 \times 4.2 \times 5$$

$$\text{c'} = 42 \text{ J K}^{-1}$$

188. How much heat is required to convert 500 g of ice at 0°C to water at 0°C? The latent heat of fusion of ice is 330 Jg^{-1}.

Ans : MAIN 2024

$$\text{Required heat Q} = \text{mL}$$

$$= 500 \times 330 = 165000 \text{ J}$$

189. 85 g of water at 30°C is cooled to 5°C by adding certain mass of ice. Find the mass of ice required. [Specific heat capacity of water = 4.2 $JC^{-1}{}^{0}C^{-1}$, Specific latent heat of fusion = 336 Jg^{-1}

Ans : MAIN 2024

Let the amount of ice = m gram
Heat lost by water = $85 \times 4.2 \times (30 - 5)$
Heat lost by ice = $m \times 336 + m \times 4.2 \times (5 - 0)$
Applying principle of calorimetry,

$$85 \times 4.2 \times (30 - 5)$$

$$= m \times 336 + m \times 4.2 \times (5 - 0)$$

or $$8925 = 357\, m$$

$$m = 25 \text{ g}$$

190. Two metallic blocks P and Q having masses in ratio 2 : 1 are supplied with the same amount of heat. If their temperatures rise by same degree, compare their specific heat capacities.

Ans : MAIN 2020

Given, $$\frac{m_P}{m_Q} = \frac{2}{1},$$

$$Q = mcQ,$$

since Q and q are same, therefore, we have

$$\frac{C_P}{C_Q} = \frac{m_Q}{m_P} = \frac{1}{2}$$

191. A copper vessel of mass 100 g contains 150 g of water at 50°C. How much ice is needed to cool it to 5°C ?
Given: Specific heat capacity of copper = 0.4 J $g^{-1}\,^{\circ}C^{-1}$
Specific heat capacity of water = 4.2 J $g^{-1}\,^{\circ}C^{-1}$
Specific latent heat of fusion of ice = 336 J g^{-1}

Ans : MAIN 2016

Let m g of ice is required.
Assuming that no heat energy is lost,
Heat energy required for ice to melt = Heat energy given by calorimeter and water

$$m_{\text{ice}} L + m_{\text{ice}} C_W (5 - 0)$$

$$= m_{\text{Cu}} C_{\text{Cu}} (50 - 5) + m_W C_W (50 - 5)$$

$$m_{\text{ice}} (336 + 5 \times 4.2)$$

$$= 100 \times 0.4 \times 45 + 150 \times 4.2 \times 45$$

$$m_{\text{ice}} \times 357 = 1800 + 28350$$

$$m_{\text{ice}} = \frac{1800 + 28350}{357}$$

$$= 84.45 \text{ g}$$

192. A refrigerator converts 100 g of water at 20°C to ice at -10°C in 35 minutes.
Calculate the average rate of heat extraction in terms of watt.
Specific heat capacity of ice = 2.1 J $g^{-1}\,^{\circ}C^{-1}$
Specific heat capacity of water = 4.2 J $g^{-1}\,^{\circ}C^{-1}$
Specific latent heat of fusion of ice = 336 J g^{-1}

Ans : COMP 2015

Let the average rate of heat extraction be P.
According to the question in refrigerator 20°C water will convert into 0°C water +0°C water will convert into 0°C ice +0°C ice will be converted into -10°C ice = total heat extracted in 35 minutes.
i.e. $m_w c_w \times \Delta t + m_w L + m_{\text{ice}} c_{\text{ice}} \times \Delta t$

$$= P \times t$$

$$100 \times 4.2 \times 20 + 100 \times 336 + 100 \times 2.1 \times 10$$

$$\{m_{\text{ice}} = m_w\}$$

$$= P \times (35 \times 60)\,\text{s}$$

$$8400 + 33600 + 2100 = P \times 2100\,\text{s}$$

$$44100 \text{ J} = P \times 2100\,\text{s}$$

$$P = \frac{44100}{2100} = 21 \text{ W}$$

193. Heat energy is supplied at a constant rate to 100 g of ice at 0°C. The ice is converted into water at 0°C in 2 minutes. How much time will be required to raise the temperature of water from 0°C to 20°C ?
[Given: specific heat capacity of water = 4.2 J $g^{-1}\,^{\circ}C^{-1}$, specific latent heat of ice = 336 J g^{-1}]

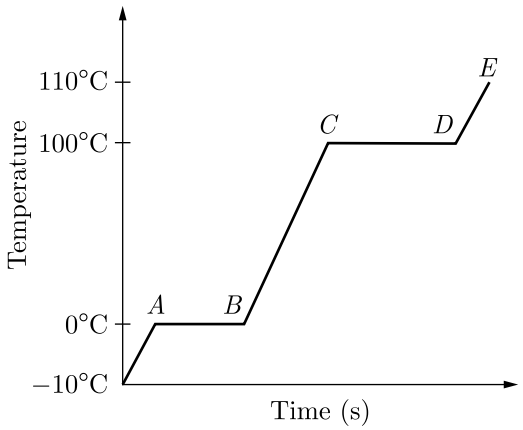
Ans : SQP 2014

Heat supplied to convert 100 g of ice at 0°C to 100 g water at 0°C in 2 min,

NODIA

is more its heat capacity must be less.
Hence, Heat capacity of A is less than that of B.

166. A piece of ice at –10°C is heated at a constant rate. The variation of temperature with heat input is shown in the graph below :
(i) What is represented by AB and CD ?
(ii) What conclusion can you draw regarding the nature of ice from the given graph ?



Ans : SQP 2005

(i) AB corresponds to the time interval in which ice is melting to form water.
CD corresponds to the time interval in which water (at 100°C) boils to form water vapour (steam) at 100°C.
(ii) The ice is pure since it melts at 0°C. The ice is initially at –10°C. It may have been formed under high pressure.

167. Give one example of each where high specific heat capacity of water is used (i) in cooling and (ii) as heat reservoir.

Ans : SQP 2002

(i) Water is often used to cool the radiators of the engines in motorcars and trucks, etc., as it can draw large amount of heat without much rise in its own temperature.
(ii) Water is often used as a heat reservoir in hot water bottles for fomentation or in hot water pipes for heating rooms in cold countries as it can release large amount of heat while it is cooling.

168. (i) What is the principle of method of mixtures?
(ii) What is the other name given to it?
(iii) Name the law on which the principle is based.

Ans : COMP 2016

(i) When a hot body is kept in contact (or mixed) with a cold body, heat energy passes from the hot body to the cold body, till both the bodies attain the same temperature. If no heat energy is exchanged with the surroundings, i.e. the system is fully insulated, heat energy lost by the hot body = heat energy gained by the cold body.
(ii) This is also known as the principle of calorimetry.
(iii) This principle is based on the law of conservation of energy.

169. What material is the calorimeter made up of ? Why ?

Ans : MAIN 2016

Calorimeter is made up of copper, a good conductor so that it attains the temperature of its contents in a very short time. It has comparatively low specific heat capacity ($390\ J\ kg^{-1}\ K^{-1}$) than that of water ($4200\ J\ kg^{-1}\ K^{-1}$). Therefore, it will take only a very little part of the heat energy given out by the hot solid in the experiment of the determination of specific heat capacity of the solid. More heat will be available for water to have a larger rise in temperature which can be measured accurately.

170. State in brief, the meaning of each of the following:
(i) The heat capacity of a body is $50\ J\,^{\circ}C^{-1}$.
(ii) The specific latent heat of fusion of ice is $336000\ J\ kg^{-1}$.
(iii) The specific heat capacity of copper is $0.4\ J\ g^{-1}\,^{\circ}C^{-1}$.

Ans : MAIN 2016

(i) $50\ J\,^{\circ}C^{-1}$ means the body requires 50 J of heat energy for every 1°C rise in temperature.
(ii) $336000\ J\ kg^{-1}$ means that every 1 kg of ice will require 336000 J of heat energy to melt and form water without change in its temperature.
(iii) $0.4\ J\ g^{-1}\,^{\circ}C^{-1}$ means that 1 g of copper will require 0.4 J of heat energy to raise its temperature by 1°C.

171. (i) What is the principle of method of mixtures ?
(ii) Name the law on which this principle is based.

Ans : SQP 2002

(i) When a hot body is mixed or kept in contact with a cold body, there is a transfer of heat from the body at higher temperature to a body at lower temperature till both the bodies

Downloaded from www.pdf.tube

146. Explain why no tracks are left on the ice during ice skating.

Ans : COMP 2000

The weight of the body acts on a very small area of skate, in comparison to that of ice. Under this high pressure, ice melts to form after below 0°C. The water so formed makes the surface water skating more slippery. But as soon as the skater moves further, the water does not experience any pressure and refreezes into ice leaving no track on ice surface.

147. State two ways, other than direct heating, by which a given quantity of liquid can be made to evaporate more quickly.

Ans : SQP 2004

Evaporation can be made faster by
(i) Increasing the surface area of the liquid.
(ii) Blowing, air over the liquid.
(iii) Decreasing the pressure on the surface of liquid.

148. If, in a central heating system, steam enters a radiator pipe at 100°C and water leaves the radiator pipe at 100°C, can this radiator pipe heat a room? Give an explanation for your answer.

Ans : COMP 2004

Yes, it will heat the room. Though there is no fall in temperature but latent heat of steam helps heating the room. Each kilogram of steam condensed gives out 2268×10^3 J of heat energy to the surroundings. Thus, the room gets heated up.

149. On a hot summer day, the water in a swimming pool remains comfortably cool. Give reason.

Ans : MAIN 2004

On a hot summer day when temperature is 40°C and above, the water in a swimming pool remains comfortably cool (may be around 25°C) because of very high specific heat of water. The rise in temperature $\left(\Delta T = \frac{Q}{mc}\right)$ is inversely proportional to the specific heat capacity. So the rise in the temperature of water is very small.

150. Iron has specific heat capacity of 0.479 kJ $kg^{-1}\,°C^{-1}$. What can be unilateralist by this statement ?

Ans : MAIN 2004

Specific heat is defined as the amount of heat required to raise the temperature of unit mass of a substance through 1°C. If iron has specific heat capacity of 0.419 $kg^{-1}\,°C^{-1}$. It means that if one kilogram of iron is heated through 1°C, then amount of heat energy required will be 0.419 kJ.

151. Give two reasons as to why copper is preferred over other metals for making calorimeters.

Ans : COMP 2012

Copper is preferred over other metals for making calorimeters because
(i) Copper being a good conductor attains the temperature of its content in a very short time.
(ii) Comparatively its specific heat capacity (390 J $kg^{-1}\,K^{-1}$) being lower than that of water (4200 J $kg^{-1}\,K^{-1}$), copper will take a very little part of heat energy given out by the hot solid. Thus, more heat will be available for water to have a larger rise in temperature which can be measured accurately.

152. What is meant by specific heat capacity of a substance?

Ans : SQP 2001

Specific heat capacity of a substance is defined as the amount of heat required to change the temperature of unit mass of that substance through 1°C.

153. Why does the heat supplied to a substance during its change of state not cause any rise in its temperature?

Ans : MAIN 2001

Heat supplied to a substance during its change of state increases the potential energy of its molecules but no increase in kinetic energy. Since rise in temperature is dependent on kinetic energy of the molecules. Hence, no rise in its temperature takes place during its change of state.

THREE MARKS QUESTIONS

154. The diagram below shows a cooling curve for a substance:
(a) State the temperatures at which the substance condenses.
(b) The temperature range in which the substance is in liquid state.

NODIA

Let $c =$ Specific heat of composite body

Then, $(m_1 + m_2)\, c = m_1 c_1 + m_2 c_2 = 2m_1 c_1$

$$S = \frac{2m_1 c_1}{(m_1 + m_2)}$$

$$= \frac{2m_1 c_1}{m_1 + m_1\left(\frac{c_1}{c_2}\right)}$$

$$= \frac{2c_1 c_2}{c_1 + c_2}$$

178. Explain how a human body maintains a constant
(a) Does land cool at a slower or faster rate than water? Give one reason for your answer.
(b) Explain why steam pipes warm a building more effectively than hot water pipes in cold countries.

Ans : COMP 2008

(a) Land cools at a faster rate than water as the specific heat capacity of water ($c = 4200\ \text{J kg}^{-1}\text{K}^{-1}$) is about five times the specific heat capacity of land $800\ \text{J kg}^{-1}\text{K}^{-1}$) and for a given quantity of heat transfer Q and a given mass m, change in temperature ΔT is inversely proportional to the specific heat capacity,
i.e. $\left(\Delta T \propto \frac{1}{c}\right)$

(b) Steam pipes warm a building more effectively than hot water pipes in cold countries as steam due to its very high specific latent heat of vaporisation (2260 kJ/kg) releases 2260 kJ per kg extra heat energy compared with the heat energy released by the boiling water of the same mass.

179. State the principle of specific heat determination by method of mixtures.

Ans : SQP 2011

Principle of determination of specific heat capacity. When two bodies of known mass and temperatures are brought into thermal contact with each other, heat flows (Q_1) from the body at higher temperature to the body at lower temperature (Q_2) until the two attain the same temperature. Following the law of conservation of energy, the heat lost by the hot body is equal to the heat gained by the cold body provided no heat is lost to the surrounding, i.e.
Heat lost by hot body = Heat gained by cold body

i.e. $m_1 c_1 (T_1 - T) = m_2 c_2 (T - T_2)$

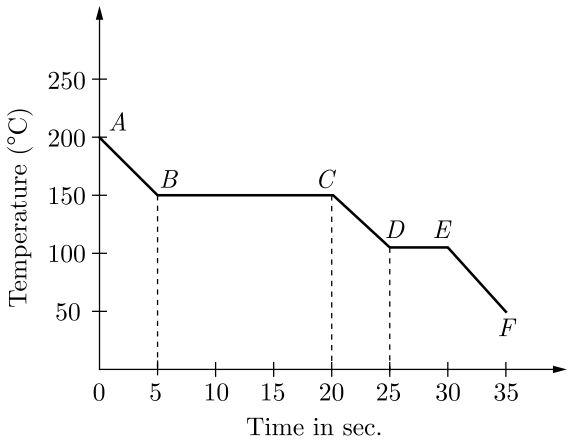
where m_1, m_2, c_1, c_2, T_1 and T_2 represent the mass, specific heat capacity and temperature of both the bodies (hot and cold) respectively and T is the final temperature of the mixture.

180. Can heat be added to a substance without causing the temperature of the body to rise? If so, does this contradict the concept of heat as energy in the process of transfer because of a temperature difference?

Ans : MAIN 2011

Yes, heat can be added to a body without causing the temperature of the body to rise as in the case of latent heat being added to cause a change of state of the body. This does not contradict the concept of heat as energy in transit due to temperature difference because there is a big difference of temperature black and white the substance and the source from which heat is received by the substance and in this case, the heat supplied increases the intermolecular distance.

181. The graph represents a cooling curve for a substance being cooled from higher temperature to a lower temperature.
(i) What is the boiling point of the substance ?
(ii) What happens in the region DE ?
(iii) Why is region DE shorter than the region BC ?



Ans : COMP 2011

(i) The boiling point of the substance is 150°C.
(ii) In the region DE, the substance undergoes a change of state from liquid to solid phase.
(iii) The region DE is shorter than the region BC because the latent heat of fusion is much less than the latent heat of vaporisation.

FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

Click Here to Buy book on Amazon

A will be more useful in radiators. This is because A will extract more heat without much change in its temperature as it has high specific heat capacity.

160. (i) It is observed that the temperature of the surroundings starts falling when the ice in a frozen lake starts melting. Give a reason for the observation.
(ii) How is the heat capacity of the body related to its specific heat capacity?

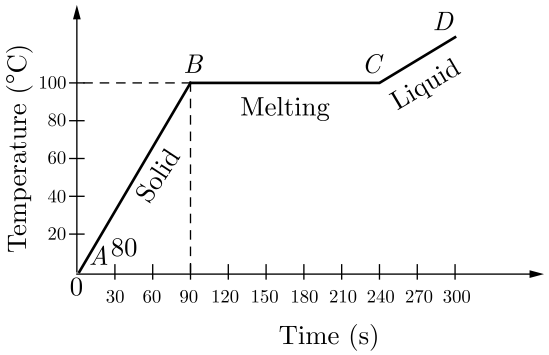
Ans : MAIN 2013

(i) When the ice in a frozen lake starts melting, it draws latent heat (336 Jg) from the surroundings which results in lowering of temperature of the surroundings.
(ii) Heat capacity = mass × specific heat capacity.

161. Some ice is heated at a constant rate, and its temperature is recorded after every few seconds, till steam is formed at 100°C. Draw a temperature-time graph to represent the change. Label the two phase changes in your graph.

Ans : COMP 2016

The graph is as shown :



162. Differentiate between heat capacity and specific heat capacity.

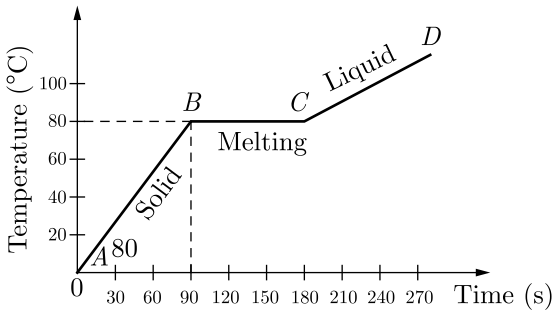
Ans : COMP 2012

Specific heat capacity of a body is the amount of heat energy required to raise the temperature of unit mass of that substance through 1 K. Its SI unit is $J\,kg^{-1}\,K^{-1}$.
Heat capacity of a body is the amount of heat energy required to raise its temperature by 1 K. Its SI unit is $J\,K^{-1}$.

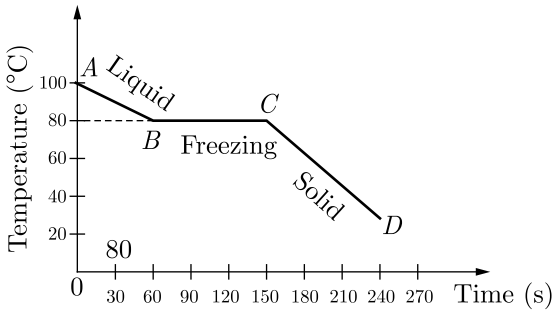
163. Draw a well labelled diagram showing the changes taking place (i) while heating and (ii) while cooling a substance.

Ans : MAIN 2003

(i) Heating curve.



(ii) Cooling curve.



NODIA

164. Explain why steam pipes warm a building more effectively than hot water pipes in cold countries.

Ans : SQP 2003

We know that the 'heat content' of 1 kg of steam (at 100°C) is more than that of 1 kg of boiling hot water (also at 100 °C) by nearly 2268 kJ (the specific latent heat of vaporisation of water). Each kilogram of steam can thus, give out nearly 2268 kJ of heat more than each kilogram of boiling hot water. This makes steam more effective than boiling hot water in warming a building.

165. An equal quantity of heat is supplied to two substances A and B. The substance A shows a greater rise in temperature. What can you say about the heat capacity of A as compared to that of B ?

Ans : COMP 2010

Heat absorbed by a substance is given by

$$H = ms\theta$$

H = Heat capacity × Rise of temperature

$= c\theta$, where c is the heat capacity.

Since H is same for both A and B, it is clear that heat capacity is inversely proportional to the rise of temperature. Since the rise of temperature of A

but its temperature does not rise sufficiently.

(iii) Water has the highest specific heat capacity of 4.2 Jg^{-1} $°C^{-1}$ and hence it can absorb large amount of heat energy, without rising in temperature sufficiently. Thirst is a natural signal, signifying that the body produces more heat energy than required. Thus, water is ideal for quenching thirst, because it can absorb large amount of heat energy.

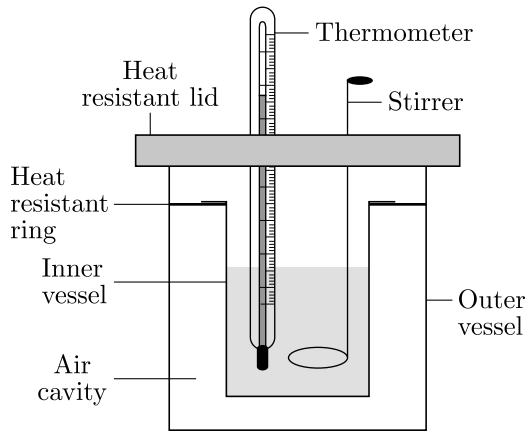
(iv) Water has the highest specific heat capacity of 4.2 Jg^{-1} $°C^{-1}$. Thus, it can extract large amount of heat energy rapidly from the site of burn and hence gives a lot of relief.

185. What is the calorimeter ? Give the construction of calorimeter with labelled diagram ?

Ans : COMP 2017

A calorimeter is a vessel in which heat exchanges can occur and it is used for measuring heat flow (for the determination of specific heat capacity, heat of transformation, etc.).

It is usually made up of copper. To reduce heat loss by radiation, it is polished both from inside and outside. It is placed in a larger container which is of insulating material such as wooden box. The space between the calorimeter and the wooden jacket is filled with some poor conductor such as wool, cotton, etc. It is covered with a wooden lid which has holes for copper stirrer (used for mixing of the contents of calorimeter) and the thermometer to measure the temperature of the contents.



Calorimeter

186. Explain the following :

(i) Why do sandy soils, get heated up quickly as compared to wet soils?

(ii) Why does a wise farmer water his fields, if weather forecast is frost?

(iii) Why are big tubs of water kept in underground cellars for storing fresh fruit and vegetables, in cold countries?

(iv) Explain why water is used in hot water bottles for fomentation and also as a universal coolant.

Ans : MAIN 2017

(i) The specific heat capacity of sand is about five times less than water. Thus, when heat from the sun is received equally by sandy soil and wet soil, the sandy soil gets heated up rapidly as compared to wet soil. It is because water absorbs large amount of heat energy, but its temperature does not rise sufficiently.

(ii) Frost can seriously damage the leaves and fruit of plants. When a farmer waters his fields, during night, this water gives large amount of heat energy, because 1 g of water will liberate 4.2 J of energy for every 1°C fall in temperature. Thus, the air around the field is saturated with heat energy and its temperature does not fall below 0°C. Thus, no frost is formed.

(iii) During sub-zero temperatures, the water within the cells of fruits Sand vegetables freezes and hence, damages them. To avoid such damage huge water tubs are kept. The water gives off 4200 J of heat energy for every one kg for 1°C fall in temperature. Thus, it does not allow the temperature of cellar to fall below 0 °C and hence, there is no damage to fresh fruits or vegetables.

(iv) Hot water bottles are used for fomentation since water does not cool rapidly due to its large value of specific heat capacity (i.e. 4200 J kg^{-1} K^{-1}). On the other side, water due to its large specific heat capacity can extract more heat on passing around machines as a coolant. Therefore, water is used in hot water bottles for fomentation and also as a universal coolant.

NUMERICAL QUESTION

187. A solid of mass 60 g at 100°C is placed in 150 g of water at 20°C. The final steady temperature is 25°C. Calculate the heat capacity of solid.

[sp. heat capacity of water = 4.2 J g^{-1} K^{-1}]

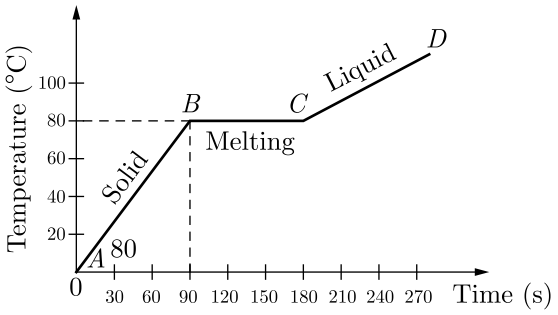
Ans : SQP 2025

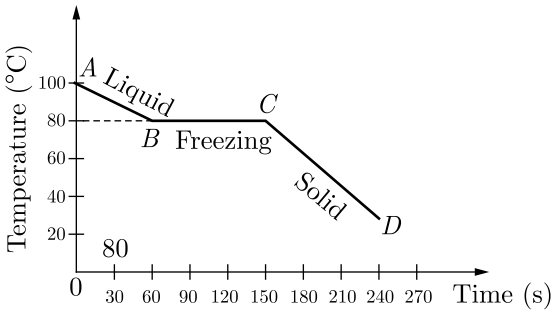
FOUR MARKS QUESTIONS

182. Draw a neat and labelled diagram of temperature versus time, when a substance is heated from 0°C to 90°C. Also, draw another curve when the molten substance cools to room temperature. How will you determine the melting point and freezing point from the graphs drawn?

Ans : COMP 2009

The graphs are as shown :





In graph (i), CB part is parallel to the time axis. This part represents change of solid substance without rise in temperature to liquid state. This temperature at which substance starts to melt is called the melting point.

In graph (ii), the part AB indicates that the temperature of liquid substance decreases continuously till it reaches point B, the part BC indicates that the substance is solidifying and solidification is complete at point C. The temperature corresponding to point C is called freezing point.

Thus, we find that the freezing and melting point of substance is 80°C.

183. Explain the following :

(i) Bottled drinks are cooled more effectively when surrounded by lumps of ice than iced water.

(ii) Why does atmospheric temperature fall after a hail storm?

(iii) Why does the weather become pleasant when it starts freezing in cold countries?

(iv) Why is water used as a coolant in motor car radiators?

Ans : SQP 2022

(i) Every 1 kg of ice at 0°C absorbs 336000 J of heat energy to form water at 0°C. As ice can extract 336000 J of heat energy, more than water at 0°C, therefore, it cools the bottled drinks more effectively.

(ii) Ice has the highest specific latent heat of fusion of 336000 Jkg^{-1}. Thus, when small pieces of hail melt, they absorb large amount of heat energy from the surroundings. This leads to a decrease in atmospheric temperature.

(iii) Ice has the highest specific latent heat of fusion of 336000 Jkg^{-1}. Thus, every kilogram of water at 0°C, on freezing releases 336000 J of heat energy. As enormous amount of heat energy is released into the atmosphere, therefore, weather becomes pleasant.

(iv) Water has the highest specific heat capacity of 4.2 $Jg^{-1}\ °C^{-1}$ and its temperature does not rise beyond 100 °C. Thus, it can absorb large amount of heat from the working engine, which is then radiated through the radiator. This effectively controls the temperature of the engine, thereby increasing its efficiency.

184. Explain the following :

(i) Why does the temperature in hot summer, falls sharply after a sharp shower?

(ii) Why do sandy soils, get heated up quickly as compared to wet soils?

(iii) Why is water considered as the best liquid for quenching thirst?

(iv) Why is it advisable to pour cold water over burns, caused on human body by hot solids?

Ans : SQP 2022

(i) Water has the highest specific heat capacity of 4.2 $Jg^{-1}\ °C^{-1}$. Thus, when there is a sharp shower the water evaporates. In doing so, it absorbs large amount of heat from surroundings, hence, temperature falls sharply.

(ii) The specific heat capacity of sand is about five times less than water. Thus, when heat from the sun is received equally by sandy soil and wet soil, the sandy soil gets heated up rapidly as compared to wet soil. It is because water absorbs large amount of heat energy,

Downloaded from www.pdf.tube

$$Q = mL$$
$$= 100 \times 336 = 33600\ \text{J}$$

Power, $$P = \frac{Q}{t}$$
$$= \frac{33600}{120} = 280\ \text{W}$$

Let the time required to raise the temperature of water from 0°C to 20°C.
According to the principle of calorimetry

$$\text{Power} \times \text{time} = mC\Delta\theta$$
$$280 \times t = 100 \times 4.2 \times (20 - 0)$$
$$t = \frac{100 \times 4.2 \times 20}{280}\ \text{s}$$
$$= 30\ \text{s}$$

194. 50 g of metal piece at 27°C requires 2400 J of heat energy so as to attain a temperature of 327°C. Calculate the specific heat capacity of the metal.

Ans : COMP 2014

Let the specific heat capacity of metal is C.

Given, $m = 50\ \text{g};\ Q = 2400\ \text{J}$
$\theta_1 = 27^\circ\text{C};\ \theta_2 = 327^\circ\text{C}$

$$Q = mC(\theta_2 - \theta_1)$$
$$C = \frac{Q}{m(\theta_2 - \theta_1)}$$
$$= \frac{2400\ \text{J}}{50\ \text{g} \times (327 - 27)^\circ\text{C}}$$
$$= 0.16\ \text{Jg}^{-1}{}^\circ\text{C}^{-1}$$

195. A calorimeter of mass 50 g and specific heat capacity $0.42\ \text{J g}^{-1}{}^\circ\text{C}^{-1}$ contains some mass of water at 20°C. A metal piece of mass 20 g at 100°C is dropped into the calorimeter. After stirring, the final temperature of the mixture is found to be 22°C. Find the mass of water used in the calorimeter.
[Specific heat capacity of the metal piece $= 0.3\ \text{J g}^{-1}{}^\circ\text{C}^{-1}$, Specific heat capacity of water $= 4.2\ \text{J g}^{-1}{}^\circ\text{C}^{-1}$]

Ans : MAIN 2013

Let the mass of water be m_w
According to the principle of calorimetry
Heat lost by metal piece = Heat gained by (calorimeter + water)

$$m_s C_s(\theta_s - \theta) = m_c C_c(\theta - \theta_c) + m_w C_w(\theta - \theta_c)$$
$$20 \times 0.3 \times (100 - 22)^\circ\text{C}$$
$$= 50 \times 0.42 \times (22 - 20)^\circ\text{C}$$
$$+ m_w \times 4.2 \times (22 - 20)^\circ\text{C}$$
$$8.4\ m_w = 426$$
$$m_w = 50.7\ \text{g}$$

196. How much heat energy is released when 5 g of water at 20°C changes to ice at 0°C ?
[Specific heat capacity of water $= 4.2\ \text{J g}^{-1}{}^\circ\text{C}^{-1}$, Specific latent heat of fusion of ice $= 336\ \text{J g}^{-1}$]

Ans : COMP 2001

Amount of heat energy released, Q = heat energy released when 20°C water changes to 0°C water + 0°C water changes into 0°C ice

$$= mc\Delta\theta + mL$$
$$= m(c\Delta\theta + L)$$
$$= 5\ \text{g}[4.2 \times (20 - 0)^\circ\text{C} + 336]$$
$$= 5\,[84 + 336]$$
$$= 5 \times 420 = 2100\ \text{J}$$

197. Water falls from a height of 50 m. Calculate the rise in the temperature of water when it strikes the bottom. (Take $g = 10\ \text{m s}^{-2}$; specific heat capacity of water $= 4200\ \text{J/kg}^\circ\text{C}$).

Ans : SQP 2001

Given, $h = 50\ \text{m},\ g = 10\ \text{m/s}^2$
$c_w = 4200\ \text{J/kg}^\circ\text{C}$
$\Delta\theta = ?$

$$mgh = mc_w\Delta\theta$$
$$\Delta\theta = \frac{gh}{c_w}$$
$$= \frac{10 \times 50}{4200}$$
$$= 0.12^\circ\text{C}$$

198. Calculate the amount of heat released when 5.0 g of water at 20°C is changed into ice at 0°C.
(Specific heat capacity of water = 4.2 J/g °C
Specific latent heat of fusion of ice = 336 J/g).

Ans : COMP 2016

Amount of heat released when 5.0 g of water at 20°C is changed into ice at 0°C

$$= mc\Delta\theta + mL$$
$$= m(c\Delta\theta + L)$$
$$= 5.0g\,[4.2 \times (20)^\circ\text{C} + 336]$$
$$= 5.0g\,[84.0 + 336]$$
$$= 5.0 \times 420\ \text{J}$$
$$= 2100\ \text{J}$$

NODIA

Ans : COMP 2022

Heat of fusion, $L = \frac{Q}{m}$

For metal X, $L_x = \frac{200\text{ J}}{4\text{ kg}} = 50\text{ J/kg}$

For metal Y, $L_y = \frac{300\text{ J}}{5\text{ kg}} = 60\text{ J/kg}$

For metal Z, $L_z = \frac{300\text{ J}}{6\text{ kg}} = 50\text{ J/kg}$

$$L_y > L_x = L_z$$

218. Calculate the amount of ice which is required to cool 150 g of water contained in a vessel of mass 100 g at 30°C, such that the final temperature of the mixture is 5°C. (Take specific heat capacity of material of vessel as $0.4\text{ J g}^{-1}\,^\circ\text{C}^{-1}$, specific latent heat of fusion of ice $= 336\text{ J g}^{-1}$, specific heat capacity of water $= 4.2\text{ J g}^{-1}\,^\circ\text{C}^{-1}$).

Ans : COMP 2022

According to the principle of mixtures
Heat lost by water and vessel = Heat gained by ice to melt and to raise the temperature of water formed

$$150 \times 4.2 \times (30-5) + 100 \times 0.4 \times (30-5) = m \times 336 + m \times 4.2 \times (5-0)$$

$$m = 46.9\text{ g} \approx 47\text{ g}$$

219. Calculate the heat energy that will be released when 5.0 kg of steam at 100°C condenses to form water at 100°C. Express your answer in S.I. unit. (Specific latent heat of vaporisation of steam is 2268 kJ/kg).

Ans : SQP 2002

Mass of steam, $m_s = 5.0\text{ kg}$

Latent heat of vaporisation of steam

$$L = 2268\text{ kJ/kg}$$

Amount of heat energy released when steam at 100°C condenses to form water at 100°C,

$$Q = m_s L$$
$$= 5.0 \times 2268$$
$$= 11340\text{ kJ}$$
$$= 11340000\text{ J}$$

220. An electric heater supplies 1.8 kg of power in the form of heat to a tank of water. How long will it take to heat the 200 kg of water in the tank from 10°C to 70°C ? Assume heat losses to the surroundings to be negligible.

Ans : SQP 2002

The heat added is $1.8\text{ J/s} \times t$
The heat absorbed is $mC\Delta T$

$$= 4.184 \times 200 \times 60$$
$$= 5 \times 10^4\text{ kJ}$$
$$t = 2.78 \times 10^4\text{ s} = 7.75\text{ h}$$

221. Some hot water was added to three times its mass of cold water at 10°C and the resulting temperature was found to be 20°C. What was the temperature of the hot water?

Ans :

Let the mass of hot water be m and temperature of hot water be θ
Mass of cold water $= 3\text{ m}$
According to principle of mixtures
Heat lost by hot water = Heat gained by cold water

$$mc(\theta - 20) = 3\text{ m} \times c(20-10)$$
$$\theta - 20 = 30$$
$$\theta = 50^\circ\text{C}$$

222. The temperature of 600 g of cold water rose by 15°C when 300 g of hot water at 50°C was added to it. What was the initial temperature of cold water?
Given : specific heat capacity of water is 4.2 J/g °C.

Ans : COMP 2002

Let t be the initial temperature of cold water.
According to the principle of calorimetry
Heat lost by hot water = Heat gained by cold water

$$300 \times 4.2 \times [50 - (t+15)] = 600 \times 4.2 \times 15$$
$$300(35 - t) = 600 \times 15$$
$$35 - t = \frac{600 \times 15}{300}$$
$$t = 5^\circ\text{C}$$
$$m_{\text{ice}} = \frac{30150}{357} = 84.45\text{ g}$$

223. Steam at 100°C is passed over 1000 g of ice at 0°C. After sometime, 600 g of ice at 0°C is left and 450 g of water at 0°C is formed. Calculate the specific latent heat of vaporisation of steam. (Given : specific heat capacity of water $= 4200\text{ J/kg}\,^\circ\text{C}$ and specific latent heat of fusion of ice $= 336000\text{ J/kg}$.)

Click Here to Buy book on Amazon

Heat given by water = Heat taken by calorimeter

$$2100\ \text{J} = 0.16 \times c \times 30^\circ\text{C}$$

$$c = \frac{2100}{0.16 \times 30}$$

$$= 437.5\ \text{J/kg}^\circ\text{C}$$

203. A piece of ice of mass 40 g is dropped into 200 g of water at 50°C.
Calculate the final temperature of water after all the ice has melted. (specific heat capacity of water $= 4200\ \text{J/kg}^\circ\text{C}$, specific latent heat of fusion of ice $= 336 \times 10^3\ \text{J/kg}$).

Ans : COMP 2019

Heat gained by ice = Heat lost by water

$$mL + mst_1 = mst$$

$$(40 \times 336) + (40 \times 4.2 \times x) = 200 \times 4.2 \times (50 - x)$$

$$x = 28.3^\circ\text{C}$$

204. A block of lead mass 250 g at 27°C was heated in a furnace till it completely melted. Find the quantity of heat required (a) to bring the block to melting point, (b) to completely melt the block at its melting point. (m. pt. of lead = 327°C, specific heat capacity = 0.13 J/g K, specific latent heat of fusion = 26 J/g)

Ans : SQP 2019

(a) Heat required to raise the temperature of lead to

$$327^\circ\text{C} = mc\,\Delta t$$

$$= 250 \times 0.13 \times 300$$

$$= 9750\ \text{J}$$

(b) Heat required to melt the lead block at 327°C

$$= mL$$

$$= 250 \times 26$$

$$= 6500\ \text{J}$$

205. 40 g of water at 60°C is poured into a vessel containing 50 g of water at 20°C. The final temperature recorded is 30°C. Calculate the thermal capacity of the vessel.
(Take specific heat capacity of water as $4.2\ \text{J g}^{-1}\,^\circ\text{C}^{-1}$).

Ans : COMP 2014

Let the thermal capacity of the vessel be C'.
According to the principle of mixture

Heat given by hot water = Heat taken by cold water and vessel

$$40 \times 4.2 \times (60 - 30)^\circ\text{C} = 50 \times 4.2 \times (30 - 20)^\circ\text{C} + C' \times (30 - 20)^\circ\text{C}$$

$$C' = 294\ \text{J}^\circ\text{C}^{-1}$$

206. What will be the final temperature when 150 g of ice at 0°C is mixed with 300 g of water at 50°C. Specific heat of water-1 cal/g/°C. Latent heat of fusion of ice = 80 cal/g.

Ans : SQP 2014

Let us assume that $T > 0^\circ\text{C}$
Heat loss by water = Heat gained by ice to melt + Heat gained by water formed from ice

$$300 \times 1\,(50 - T) = 150 \times 80 + 150 \times 1 \times (T - 0)$$

$$T = 6.7^\circ\text{C}$$

Hence, our assumption of $T > 0^\circ\text{C}$ was correct.

207. A molten metal weighing 150 g is kept at its melting point 800°C. When it is allowed to solidify at the same temperature, it gives out 75000 J of heat. What is the specific latent heat of the metal?
If its specific heat capacity is 200 J/kg K, how much additional heat will it give out in cooling to -50°C ?

Ans : MAIN 2016

Let specific latent heat of metal is L.

Mass of molten metal = 150 g

$$= 150 \times 10^{-3}\ \text{kg}$$

According to question,

$$150 \times 10^{-3} \times L = 75000$$

$$L = \frac{75000}{150 \times 10^{-3}}$$

$$= 5 \times 10^5\ \text{J/kg}$$

Additional heat given out by metal in cooling up to -50°C.

$$Q = mc\,\Delta T$$

$$= 150 \times 10^{-3} \times 200 \times 850$$

$$= 25500\ \text{J}$$

208. A vessel of negligible heat capacity contains 40 g of ice in it at 0°C. 8 g of steam at 100°C is passed into the ice to melt it. Find the final temperature of contents of the vessel.
(Specific latent heat of vaporisation of steam

NODIA

199. A refrigerator converts 100 g of water at 20°C into ice at -10°C in one hour. Determine the quantity of heat extracted per second.
[Given : specific latent heat of ice = 336 J/g and specific heat capacity of ice = 2.1 J/g °C, specific heat capacity of water = 4.2 J/g °C.]

Ans : COMP 2016

Total heat extracted per hour = heat lost by water (being cooled from 20°C to 0°C + freezing to 0°C + in reducing the temperature of ice to -10°C)

$$= mc_w \Delta t + mL + mc_{\text{ice}} \Delta t'$$
$$= m[c_w \Delta t + L + c_{\text{ice}} \Delta t']$$
$$= 100\,\text{g}[4.2 \times (20-0)^{\circ}\text{C} + 336 + 2.1 \times \{0-(-10)^{\circ}\text{C}\}]$$
$$= 100\,[84 + 336 + 21]\,\text{J}$$
$$= 44100\,\text{J}$$

$$\text{Heat extracted per second} = \frac{44100\,\text{J}}{3600\,\text{s}}$$
$$= 12.25\,\text{J/s}$$
$$= 12.25\,\text{W}$$

200. The amount of heat required to convert 1 kg of ice at -10°C to steam at 100°C is 30,37,000 J. Calculate the specific latent heat of vaporisation of steam.
Given : (Sp. heat capacity of ice = 2,100 J/kg K; Sp. heat capacity of water = 4,200 J/kg K; Specific latent heat capacity of ice = 3,36,000 J/kg).

Ans : MAIN 2011

Heat required to raise the temperature of ice from -10°C to 0°C

$$= 1 \times 2100 \times [0-(-10)]$$
$$= 21000\,\text{J}$$

$$\text{Heat required to melt ice} = 1 \times 336000$$
$$= 336000\,\text{J}$$

Heat required to raise its temperature to 100°C

$$= 1 \times 4200 \times 100$$
$$= 420000\,\text{J}$$

Heat required to vaporise water

$$= 1 \times L = 1\,L\,\text{T}$$

$$\text{Total heat required} = 21000 + 336000 + 420000 + L$$
$$30,37,000 = 777000 + L$$
$$L = 3037000 - 777000$$
$$= 2260000\,\text{J kg}^{-1}$$
$$= 2.26\,\text{MJ kg}^{-1}$$

201. 50 g of ice at 0°C is added to 300 g of a liquid at 30°C. What will be the final temperature of the mixture when all the ice has melted? The specific heat capacity of the liquid is $2.65\,\text{J g}^{-1}\,^{\circ}\text{C}^{-1}$ while that of water is $4.2\,\text{J g}^{-1}\,^{\circ}\text{C}^{-1}$. Specific latent heat of fusion of ice = $336\,\text{J g}^{-1}$.

Ans : SQP 2005

Let the final temperature of the mixture be t
According to the principle of mixtures
Heat lost by liquid = Heat gained by ice

$$300 \times 2.65 \times (30-t)$$
$$= 50 \times 336 + 50 \times 4.2 \times (t-0)$$
$$t = 7^{\circ}\text{C}$$

202. In a laboratory experiment to measure specific heat capacity of copper, 0.02 kg of water at 70°C was poured into a copper calorimeter with a stirrer of mass 0.16 kg initially at 15°C. After stirring, the final temperature reached to 45°C. Specific heat of water is taken as 4200 J/kg °C.
(a) What is the quantity of heat released per kg of water per 1°C fall in temperature?
(b) Calculate the heat energy released by water in the experiment in cooling from 70°C to 45°C.
(c) Assuming that the heat released by water is entirely used to raise the temperature of calorimeter from 15°C to 45°C, calculate the specific heat capacity of copper.

Ans : COMP 2017

(a) Quantity of heat released per kg of water per °C fall in temperature is $4200\,\text{J kg}^{-1}\,^{\circ}\text{C}^{-1}$.
(b) Quantity of heat released by water in cooling from 70°C to 45°C is $Q = mc\,\Delta T$;
where, $m = 0.02\,\text{kg}$; $c = 4200\,\text{J/kg}^{\circ}\text{C}$

$$\Delta T = (70-45)^{\circ}\text{C} = 25^{\circ}\text{C}$$
$$\text{Quantity of heat } Q = 0.02 \times 4200 \times 25^{\circ}\text{C}$$
$$= 2100\,\text{J}$$

(c) Assuming no loss of heat
Heat given out by water = Heat taken up by calorimeter but heat taken up by calorimeter $= m \times c \times \Delta T$
where, $m = 0.16\,\text{kg}$

$$\Delta T = 45^{\circ}\text{C} - 15^{\circ}\text{C}$$
$$= 30^{\circ}\text{C}$$

Downloaded from www.pdf.tube

Ans : COMP 2011

(a) (i) Heat lost by steam in terms of m_1,

$$Q_s = m_1 L_s$$
$$= m_1 \times 2268$$
$$= 2268\, m_1$$
$$(2268\ \text{kJ/kg} = 2268\ \text{J/g})$$

Heat lost by 100°C water to convert into water at 0°C,

$$Q_w = m_1 C_w \times (100 - 0)$$
$$= m_1 \times 4.2 \times 100$$
$$= 420\, m_1$$

(ii) Heat gained by ice in terms of m_2,

$$Q_i = m_2 L_i$$
$$= m_2 \times 336$$
$$= 336\, m_2 \quad (336\ \text{kJ/kg} = 336\ \text{J/g})$$

(b) According to the principle of calorimetry,
Heat lost by (steam at 100°C to condense into water at 100°C + 100°C water to convert into 0°C water) = Heat gained by ice at 0°C to convert into water at 0°C

$$Q_s + Q_w = Q_i$$
$$2268 m_1 + 420 m_1 = 336 m_2$$
$$\frac{m_2}{m_1} = \frac{2688}{336} = 8$$
$$m_2 : m_1 = 8 : 1$$

213. 0.5 kg of ice at −10°C is heated until whole of it evaporates. Find the amount of heat required. [Given : latent heat of ice $= 336 \times 10^3$ J/kg ; latent heat of steam $= 2268 \times 10^3$ J/kg and specific heat capacity of ice $= 2.1 \times 10^3$ J/kg °C]

Ans : SQP 20012

Amount of heat required to evaporate 0.5 kg of ice at −10°C = Heat required to (raise temperature of ice from −10°C to 0°C + melt ice + raise the temperature of water from 0°C to 100°C + vaporise the water)

$$= [m\, c_{\text{ice}}\, \Delta t + m\, L_{\text{ice}} + m\, c_w\, \Delta t' + m\, L_{\text{steam}}]$$
$$= m[c_{\text{ice}}\, \Delta t + L_{\text{ice}} + c_w\, \Delta t' + L_{\text{steam}}]$$
$$= 0.5[\{2.1 \times 10^3 \times (0 - (-10))\} + 336 \times 10^3 + 4.2 \times 10^3 \times (100 - 0) + 2268 \times 10^3]$$
$$= 0.5[21 \times 10^3 + 336 \times 10^3 + 420 \times 10^3 + 2268 \times 10^3]$$
$$= 1.5225 \times 10^6\ \text{J}$$

214. 200 g of hot water at 80°C is added to 300 g of cold water at 10°C. Calculate the final temperature of the mixture of water. Consider the heat taken by the container to be negligible. [Specific heat capacity of water is 4200 J $\text{kg}^{-1}\,^\circ\text{C}^{-1}$]

Ans : COMP 2012

Let the final temperature of the mixture be x.
According to the principle of mixture

Heat lost by a body = Heat gained by a body

$$200 \times c \times (80 - x) = 300 \times c \times (x - 10)$$
$$16000 - 200x = 300x - 3000$$
$$19000 = 500x$$
$$x = 38^\circ\text{C}$$

215. 40 g of ice at 0°C is used to bring down the temperature of a certain mass of water at 60°C to 10°C. Find the mass of water used.
[Specific heat capacity of water = 4200 J $\text{kg}^{-1}\,^\circ\text{C}^{-1}$]
[Specific latent heat of fusion of ice = 336×10^3 J kg^{-1}]

Ans : MAIN 2012

Let the mass of water be m.
According to the principle of calorimetry
Heat lost by hot water = Heat gained by ice
m × 4.2 × (60°C − 10°C)

$$= (40 \times 336) + (40 \times 4.2 \times 10)$$
$$m = 72\ \text{g}$$

216. A hot solid of mass 60 g at 100°C is placed in 150 g of water at 20°C. The final steady temperature recorded is 25°C. Calculate the specific heat capacity of the solid.
[Specific heat capacity of water = 4200 J $\text{kg}^{-1}\,^\circ\text{C}^{-1}$]

Ans : MAIN 2022

Let the specific heat capacity of the solid be c.
According to the principle of calorimetry

Heat lost by hot solid = Heat gained by water

$$60\ \text{g} \times c \times (100 - 25)\,^\circ\text{C}$$
$$= 150 \times 4.2 \times (25 - 20)$$
$$c = \frac{150 \times 4.2 \times 5}{60 \times 75}\ \text{J}\text{g}^{-1}\,^\circ\text{C}^{-1}$$
$$= 0.7\ \text{J}\,\text{g}^{-1}\,^\circ\text{C}^{-1}$$

217. Materials X, Y and Z are solids that are at their melting temperatures. Material X requires 200 J to melt 4 kg, Y requires 300 J to melt 5 kg and Z requires 300 J to melt 6 kg. Rank the materials according to their heats of fusion in descending order.

NODIA

The kettle contains 1.5 kg of water. The kettle is switched on.

(i) Calculate the energy needed to raise the temperature of the water by 50 °C.
Specific heat capacity of water = 4200 J/kg °C.
Use the equation

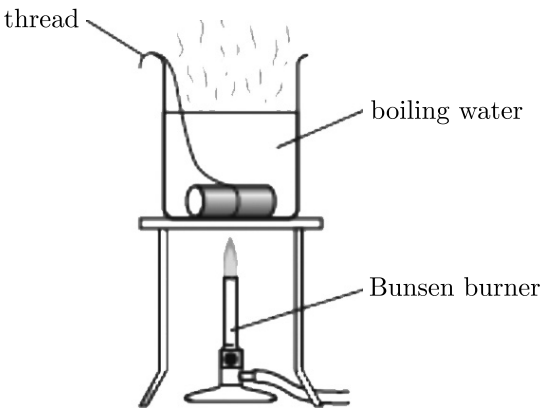
(ii) The amount of energy, E, needed to bring the water to boiling point is 670 000 *J*.
The kettle has a power of 3500 W.
Calculate the time *t*, it takes time to bring the water to boiling point

Ans :

(i) $$\Delta Q = m \times c \times \Delta\theta$$
$$\Delta Q = 1.5 \times 4200 \times 50$$
$$= 315000 \text{ J}$$

(ii) $$P = \frac{E}{t}$$
$$3500 = \frac{670000}{t}$$
$$t = \frac{670000}{3500}$$
$$= 191.42 \text{ s} \approx 192 \text{ s}$$

227. A student wants to determine the specific heat capacity of copper. Figure shows a piece of copper, with a thread tied around it, in a glass beaker of boiling water.



The student leaves the piece of copper in the boiling water so that the copper reaches a temperature of 100 °C. The student uses the thread to take the piece of copper out of the boiling water.
The student puts the hot piece of copper into a different beaker of cold water at 20 °C.
The apparatus is shown in Figure 2.

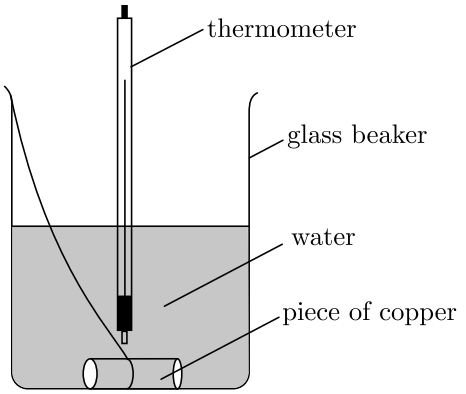


Figure 2

The student assumes that the thermal energy gained by the water equals the thermal energy lost by the piece of copper. The water and copper both reach a temperature of 22 °C.The cold water gains 1050 J of energy. The mass of the piece of copper is 0.058 kg.

(i) Calculate a value for the specific heat capacity of copper.

(ii) The value for the specific heat capacity of copper obtained from the student's results is lower than the correct value.
State two ways that the experiment could be improved to give a value that is closer to the correct value.

Ans :

(i) Change in thermal energy = mass × specific heat capacity × change in temperature

$$\Delta Q = m \times c \times \Delta\theta$$
$$c = \frac{\Delta Q}{m \times \Delta\theta}$$
$$c = \frac{1050}{0.058 \times 78}$$
$$= 232.09 \text{ J/Kg °C}$$

(ii) Two ways to improve the experiment:
1. Ensure better insulation of the copper to minimize heat loss to the surroundings.
2. Use a more accurate and precise temperature measuring device to reduce errors in temperature readings.

www.nodia.in

Click Here to Buy book on Amazon

Ans : MAIN 2002

Here total mass of ice before passing steam $= 1000\,\text{g}$ (at 0°C)
Mass of ice left after passing steam $= 600\,\text{g}$ (at 0°C)
Mass of ice melted by steam to form water $= 400\,\text{g}$ (at 0°C)
Mass of steam condensed to form water at

$$0^\circ\text{C} = 450 - 400 = 50\,\text{g}$$

Hence, Heat gained by ice

$$= \frac{400}{1000}\,\text{kg} \times 336 \times 10^3\,\text{J/kg}$$

$$= 134400\,\text{J}$$

$$\text{Heat lost by steam} = \frac{50}{1000}\,\text{kg} \times L + \frac{50}{1000} \times 4200 \times 100$$

$$= \left[\frac{L}{20} + 21000\right]\text{J}$$

Now, Heat gained = Heat lost

$$\frac{L}{20} + 21000 = 134400$$

$$\frac{L}{20} = (1344 - 210) \times 10^2$$

$$= 1134 \times 10^2$$

$$L = 2268 \times 10^3\,\text{J/kg}$$

224. A metal of mass 250 g is heated to a temperature of 65°C. It is then placed in 50 g of water at 20°C. The final steady temperature of water becomes 25°C. Neglecting the heat taken by the container, calculate the specific heat capacity of the metal.

Ans : COMP 2006

Let c be the specific heat capacity of metal.
Heat lost by metal piece

$$= \frac{250}{1000}\,\text{kg} \times c \times (65 - 25)^\circ\text{C}$$

$$= 10c$$

Heat gained by water

$$= \frac{50}{1000} \times 4200 \times (25 - 20)$$

$$= 1050\,\text{J}$$

Now, Heat lost by metal piece = Heat gained by water

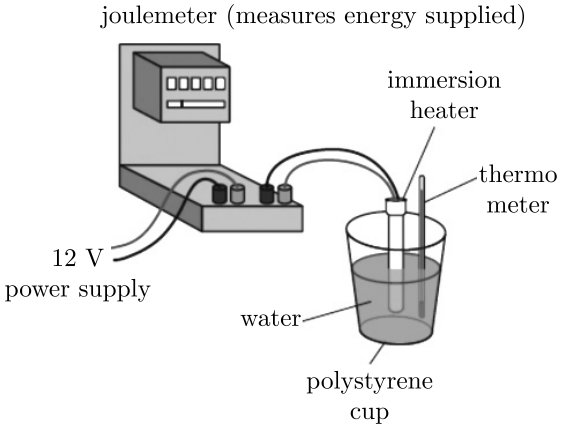
$$10c = 1050$$

$$c = 105\,\text{J/kg}^\circ\text{C}$$

FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

CASE BASED QUESTION

225. A student uses the apparatus in Figure to determine the specific heat capacity of water.



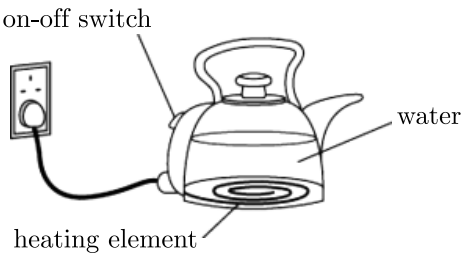
(i) State the measurements needed to calculate the specific heat capacity of water.
(ii) State two ways that the apparatus could be adapted to improve the procedure.

Ans :

(i) To calculate the specific heat capacity of water, the following measurements are needed:
1. The energy supplied to the water by the immersion heater.
2. The mass of the water.
3. The initial temperature of the water.
4. The final temperature of the water after absorbing the energy.

(ii) Two ways the apparatus could be adapted to improve the procedure:
1. Using a more accurate and sensitive thermometer to measure temperature changes more precisely.
2. Insulating the polystyrene cup to reduce heat loss to the surroundings and improve the accuracy of the experiment

226. Figure shows an electric kettle.



Downloaded from www.pdf.tube

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!

$= 2268\ \text{J/g}$,
Specific latent heat of fusion of ice $= 336\ \text{J/g}$,
Specific heat capacity of water $= 4.2\ \text{J/g}\,^\circ\text{C}$

Ans : MAIN 2016

$$\text{Mass of ice} = 40\ \text{g},$$
$$\text{Initial temp. of ice} = 0^\circ\text{C}$$
$$\text{Mass of steam} = 8\ \text{g},$$
$$\text{Initial temp. of steam} = 100^\circ\text{C}$$
$$L_v = 2268\ \text{J/g};\ L_f = 336\ \text{J/g},$$
$$c_w = 4.2\ \text{J/g}\,^\circ\text{C}$$

Let final temperature of contents is t.
By the principle of calorimetry,

Heat lost by steam = Heat gained by ice ...(1)

$$\text{Heat lost by steam} = mL_v + mc_w(100 - t)$$
$$= 8 \times 2268 + 8 \times 4.2(100 - t)$$
$$= 18144 + 33.6(100 - t)$$
$$\text{Heat gained by ice} = 40 \times 336 + 40 \times 4.2(t - 0)$$
$$= 13440 + 168t$$

From (1),

$$13440 + 168t = 18144 + 33.6 \times 100 - 33.6t$$
$$201.6t = 21504 - 13440$$
$$t = \frac{8064}{201.6} = 40^\circ\text{C}$$

209. 250 g of water at 30°C is present in a copper vessel of mass 50 g. Calculate the mass of ice required to bring down the temperature of the vessel and its contents to 5°C.
Specific latent heat of fusion of ice $= 336 \times 10^3\ \text{J kg}^{-1}$
Specific heat capacity of copper vessel $= 400\ \text{J kg}^{-1}\,^\circ\text{C}^{-1}$
Specific heat capacity of water $= 4200\ \text{J kg}^{-1}\,^\circ\text{C}^{-1}$

Ans : COMP 2013

Let the mass of ice required to bring down the temperature of the vessel and its contents to 5°C be $m\ g$.
Assuming no loss of heat by the principle of mixtures.
Heat energy lost by water and vessel = Heat energy taken by ice to melt

$$250 \times 4.2 \times (30 - 5) + 50 \times 0.4 \times (30 - 5)$$
$$= (m \times 336) + (m \times 4.2 \times 5)$$
$$26250 + 500 = 357 \times m$$
$$26750 = 357 \times m$$
$$m = 74.9\ \text{g}$$

210. A piece of iron of mass 2.0 kg has a thermal capacity of 966 J/°C.
(a) How much heat is needed to warm it by 15°C?
(b) What is its specific heat capacity in S.I. units?

Ans : SQP 2013

mass of iron piece, $m = 2.0\ \text{kg}$
Thermal capacity of iron piece, $C' = 966\ \text{J}/^\circ\text{C}$
(a) Let the amount of heat required to warm the iron piece be Q.

$$Q = C'\,\Delta\theta$$
$$= 966 \times 15$$
$$= 14490\ \text{J}$$

(b) Specific heat capacity of iron,

$$c = \frac{C'}{m}$$
$$= \frac{966}{2.0}$$
$$= 483\ \text{J kg}^{-1}\,^\circ\text{C}^{-1}$$

211. A bucket contains 8 kg of water at 25°C. 2 kg of water at 80°C is poured into it. Neglecting the heat absorbed by the bucket, calculate the final temperature of the water.

Ans : SQP 2011

Let the final temperature of water is t °C.
According to the principle of calorimetry
Heat lost by hot water = Heat gained by cold water

$$2 \times 4200 \times (80 - t) = 8 \times 4200 \times (t - 25)$$
$$80 - t = 4(t - 25)$$
$$t = \frac{180}{5} = 36^\circ\text{C}$$

212. If there is no heat loss to the surroundings, the heat released by the condensation of m_1 g of steam at 100°C into water at 100°C can be used to convert m_2 g of ice at 0°C into water at 0°C.
(a) Find:
(i) the heat lost by steam in terms of m_1.
(ii) the heat gained by ice in terms of m_2.
(b) Form a heat equation and find the ratio of $m_2 : m_1$ from it.
(Specific latent heat of vaporisation of steam $= 2268\ \text{kJ/kg}$;
Specific latent heat of fusion of ice = 336 kJ/kg.
Specific heat capacity of water = 4200 J/kg °C).

NODIA

CHAPTER 8

MODERN PHYSICS

SUMMARY

1. NUCLEUS

Atom is an identifiable part of a chemical element. The nucleus of an atom is the central part of the atom made up of positively charged protons and uncharged neutrons, collectively known as nucleons. The number of protons is represented by Z which is equal to the number of electrons arranged in the space around the nucleus. The number of protons in the nucleus is called the atomic number Z. The total number of nucleons in the nucleus is equal to the mass number A of the element.

A nuclide is a specific nucleus of an atom which is characterized by its atomic number Z and mass number A, i.e. ${}^{A}_{Z}X$. The protons and the neutrons, i.e. nucleons are bounded inside the nucleus by a strong force, known as nuclear force. It is acting between the proton-proton $(p-p)$, proton-neutron $(p-n)$ and the neutron-neutron $(n-n)$ inside the nucleus. The average distance between two nucleons is of the order of 10^{-15} m.

Unified atomic mass unit is defined as 1/12th of the mass of an atom of Carbon-12 (${}^{12}_{6}C$).

$$1u = 1.660 \times 10^{-27}\ kg$$

If in a nucleus, the number of protons is much more than the number of neutrons or the number of neutrons is much more than the number of protons, the nuclear force becomes weak and hence the nucleus becomes unstable and has a tendency to disintegrate itself. Such nuclei are said to be radioactive. The phenomenon of natural radioactivity is exhibited by the elements with atomic number higher than 82.

2. ISOTOPES

Isotopes are the atoms of the same element which have the same atomic number Z but different mass number A. These have the same number of protons but different number of neutrons in their nucleus, e.g.

$${}^{1}_{1}H,\ {}^{2}_{1}H,\ {}^{3}_{1}H,\ {}^{35}_{17}Cl,\ {}^{37}_{17}Cl,\ {}^{16}_{8}O,\ {}^{17}_{8}O,\ {}^{18}_{8}O$$

3. ISOBARS

Isobars are the atoms of different elements having same mass number but different atomic numbers, these have different number of protons, e.g.

$${}^{40}_{18}Ar \text{ and } {}^{42}_{20}Ca,\ {}^{24}_{12}Mg \text{ and } {}^{24}_{11}Na$$

4. ELECTRON VOLT (eV)

It is the amount of energy gained by an electron, when it is accelerated through a potential difference of one volt.

$$1\ eV = 1.63 \times 10^{-19}\ J$$

$$1\ MeV = 1.6 \times 10^{-19} \times 10^{6}\ J$$

$$= 1.6 \times 10^{-13}\ J$$

5. BINDING ENERGY

Binding energy is the energy required to split a nucleus into its constituent nucleons (i.e., protons and neutrons).

Mass defect is the difference between the masses of the nucleons constituting it and the rest mass of the nucleus. It is represented by Δm . It can be converted into energy using Einstein's mass energy relation $E = \Delta mc^2$, where c is the speed of light. This is the energy which binds the nucleons together in the nucleus. Therefore, binding energy may be defined as the energy equivalent to mass defect of the nucleus.

Average binding energy per nucleon is the binding energy of the nucleus divided by number of nucleons. It accounts for the stability of the nucleus. If the average binding energy per nucleon is large, the nucleus is more stable and vice-versa.

Binding energy per nucleon is the average energy required to extract one nucleon from the nucleus.

6. IONIZATION ENERGY

Ionization energy of an atom is the amount of

Click Here to Buy book on Amazon

energy required to remove an electron from the ground state so that it becomes free.

$$E = -\left(\frac{13.64Z^2}{n^2}\right)\text{eV}$$

where Z is the number of protons in the atom and n is the orbit from where electron is to be removed.

7. RADIOACTIVITY

Radioactivity is the process of spontaneous disintegration of the atomic nuclei with the emission of particles from within the nuclei of the atoms.

7.1 Rate of Disintegration

Rate of disintegration or the activity of the radioactive substances is not affected by physical or chemical conditions such as excessive heating, freezing, action of strong electric and magnetic fields, chemical reaction, etc. Radioactive decay is an exponential decay.

7.2 Half-life

Half-life is the time interval in which a given sample of radioactive substance decays to half of its original amount.

7.3 Alpha, Beta and Gamma Emission

In a radioactive process, during a (alpha) emission from a nuclide, a new element is formed whose atomic number decreases by two and mass number decreases by 4 and some amount of energy is released, i.e.

$$^{A}_{Z}X \longrightarrow {}^{A-4}_{Z-2}Y + {}^{4}_{2}\text{He}\ (\alpha\text{-particle})$$

During β (beta) emission from a nuclide, new element is formed whose atomic number is increased by one and mass number remains unaffected, i.e.

$$^{A}_{Z}X \longrightarrow {}_{Z+1}{}^{A}Y + {}_{-1}{}^{0}e\ (\text{electron})$$

Note : electron does not exist in the nucleus. It is released by the conversion of one neutron to a proton within the nucleus by emitting an electron also. This is known as beta particle.

$$\underset{(\text{neutron})}{{}^{1}_{0}n} \longrightarrow \underset{(\text{proton})}{{}^{1}_{1}p} + \underset{(\beta-\text{particle})}{{}^{0}_{-1}e} + \underset{(\text{anti}-\text{neutrino})}{\bar{\nu}}$$

In this process, the parent and daughter nuclei are isobars.

γ-ray emission is followed by an α or β emission due to which the daughter or parent nucleus comes in a state of excitation (i.e. excess energy state). The excess energy is released in the form of γ-radiation (or γ-ray photon). It does not have charge or mass. Therefore, due to its emission there is no change in the nucleus.

In a single radioactive decay, α and β particles are not emitted simultaneously. It will be either an α-emission or β-emission accompanied by γ -emission.

8. X-RAYS

X-rays are waves similar to light waves but of much shorter wavelength a bout 10^{-10} m (or 0.1 nm or 1 Å). X-rays are produced when fast moving electrons or cathode rays strike a metallic target of high atomic weight and high melting point such as the walls or anode of a low-pressure discharge tube. X-rays are invisible to eye but affect the photographic plate in the same manner as do the light rays.

9. BACKGROUND RADIATION

Background radiation is the radiation present in the atmosphere at any place even when there is no radioactive source in the vicinity. Its possible sources are (i) cosmic radiation (mostly proton showers) coming from outer space, (ii) rocks in the earth containing traces of radioactive substances, (iii) naturally occurring radioisotopes, (iv) artificial radioisotopes, (v) products from nuclear explosions.

10. NUCLEAR REACTION

When a nucleus of any element is bombarded with a fundamental particle or a lighter nucleus, its composition changes and a new nucleus of some other element is produced. In this process elementary particle and a new lighter nucleus may be emitted along with the emission or absorption of energy. This process is called nuclear reaction. Hence, nuclear reaction is a process of transformation of an atomic nucleus into another nucleus generally by its interaction with an elementary particle or a lighter nucleus, e.g.

$$^{235}_{92}\text{U} + {}^{1}_{0}n \longrightarrow {}^{141}_{56}\text{Ba} + {}^{92}_{36}\text{Kr} + 3{}^{1}_{0}n + Q$$

In this reaction, Q represents energy emitted. The nuclear reaction in which energy is emitted, is said to be exothermic and the reaction in which energy is absorbed, is said to be endothermic.

NODIA
FOR 20 FREE SAMPLE PAPERS SET FOR ALL SUBJECTS
DOWNLOAD NODIA APP

The difference between a chemical reaction and nuclear reaction are as follows :

	Chemical reactions	Nuclear reactions
(i)	These reactions involve changes in the valence electron.	These reactions involve changes in the nucleus.
(ii)	New compound is formed.	New element is formed.
(iii)	In these reactions, atomic number of an element is not changed.	In these reactions, atomic number of the element is changed.
(iv)	Isotopes of an element give the same chemical reactions.	Isotopes of an element give different nuclear reactions.
(v)	Reactions are both reversible and irreversible.	Reactions are irreversible.
(vi)	Reactions are affected by temperature and pressure.	These reactions are not affected by temperature and pressure.
(vii)	Energy change involved in these reactions is very less as compared to nuclear reactions.	Energy change involved in these reactions is extremely large, i.e. million times more than chemical reactions.

10.1 Nuclear Fission

Nuclear fission is the process of splitting of a heavy nucleus into smaller nuclei by bombardment with the slow neutrons known as thermal neutrons, e.g.

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}n \longrightarrow {}^{236}_{92}\mathrm{U} \longrightarrow {}^{141}_{56}\mathrm{Ba} + {}^{92}_{36}\mathrm{Kr} + 3{}^{1}_{0}n + \text{energy}$$

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}n \longrightarrow {}^{133}_{51}\mathrm{Sb} \longrightarrow {}^{99}_{41}\mathrm{Nb} + 4{}^{1}_{0}n + \text{energy}$$

Fission of uranium nucleus is used in making of an atom bomb which releases large amount of energy.

10.2 Nuclear Fusion

Nuclear fusion is the process of combining two lighter nuclei into a heavier one. In this process, the mass of the resulting nucleus is less than the sum of masses of the combining nuclei. The loss in mass is released in the form of energy in accordance with Einstein's mass energy relation,

$$E = mc^2$$

$$^{2}_{1}\mathrm{H} + {}^{3}_{1}\mathrm{H} \longrightarrow {}^{4}_{2}\mathrm{He} + {}^{1}_{0}n + \text{energy}$$

The source of Sun's energy is the process of nuclear fusion.

The hydrogen bomb is also based on fusion reaction.

As safety precautions from radiation hazards the radioactive substances should be kept enclosed by lead blocks and further surrounded by concrete walls. The persons handling radioactive substances should wear protective clothing (lead gloves, lead aprons) and special badge (of photographic emulsion). To monitor the extent of exposure to harmful radiation the radioactive substances are to be handled with lead tongs.

10.3 Carbon-14 Dating

Carbon-14 dating is the process of estimating the age of rocks or fossils by calculating the ratio of C-14 and C-12 in a given specimen.

MULTIPLE CHOICE QUESTION

1. A nucleus of an atom consists of 146 neutrons and 95 protons. It decays after emitting an alpha particle. How many protons and neutrons are left in the nucleus after an alpha emission?
(a) protons = 93 , neutrons = 142
(b) protons = 95 , neutrons = 144
(c) protons = 93 , neutrons = 144
(d) protons = 95 , neutrons = 142

Ans : SQP 2025

Thus (c) is correct option.

2. A radioactive nucleus containing 128 nucleons emits a 13-particle. After 13-emission the number of nucleons present in the nucleus will be
(a) 128
(b) 129
(c) 124
(d) 127

Ans : MAIN 2024

A neutron undergoes β -decay, converting it into a proton and releasing a β -particle. As a result, the mass number stays constant while the atomic number increases by 1. Therefore, there will still be 128 nucleons (the mass number).
Thus (a) is correct option.

Downloaded from www.pdf.tube

Ans : SQP 2017

Mass.

28. The minimum amount of energy required to emit an electron from a metal surface is called ..... (energy distribution/work function).

Ans : MAIN 2015

Work function.

29. Complete the reaction :

$${}^{3}He_2 + {}^{2}H_1 \longrightarrow {}^{4}He_2 + \text{.....} + \text{Energy}$$

Ans : COMP 2019

$${}^{3}He_2 + {}^{2}H_1 \longrightarrow {}^{4}He_2 + {}^{1}H_1 + \text{Energy}$$

30. Copy and complete the following nuclear equations by filling in the correct values in the blanks :

$${}^{238}_{92}P \xrightarrow{\alpha} {}^{\cdots}_{\cdots}P_1 \xrightarrow{-\beta} {}^{\cdots}_{\cdots}P_2 \xrightarrow{-\beta} {}^{\cdots}_{\cdots}P_3$$

Ans : MAIN 2004

The complete reaction is as shown below :

$${}^{238}_{92}P \xrightarrow{\alpha} {}^{234}_{90}P_1 \xrightarrow{-\beta} {}^{234}_{91}P_2 \xrightarrow{-\beta} {}^{234}_{92}P_3$$

31. Rewrite and complete the following nuclear reaction by filling in the atomic number of Ba and mass number of Kr :

$${}^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{144}_{\cdots\cdots}Ba + {}^{\cdots\cdots}_{36}Kr + 3{}^{1}_{0}n + \text{Energy}$$

Ans : COMP 2019

$${}^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{144}_{56}Ba + {}^{88}_{36}Kr + 3{}^{1}_{0}n + \text{Energy}$$

DIRECTION : Answer the following :

32. Complete the following radioactive reaction:

$$X \rightarrow Y + {}^{4}_{2}He \rightarrow {}^{234}_{91}Z + {}^{0}_{-1}e$$

Ans : MAIN 2024

$${}^{234}_{90}X \rightarrow {}^{230}_{88}Y + {}^{4}_{2}He \rightarrow {}^{234}_{91}Z + {}^{0}_{-1}e$$

33. Uranium is available in two forms U-235 and U-238. Which of the two isotopes of Uranium is more fissionable ?

Ans : MAIN 2024

U-235.

34. State one safety precaution in the disposal of nuclear waste.

Ans : SQP 2020

Nuclear waste should be disposed off in lead containers.

35. State one factor that affects the magnitude of induced current in an AC generator.

Ans : MAIN 2024

Number of turns in armature may be increased.

36. Is it possible for a hydrogen (${}^{1}_{1}H$) nucleus to emit an alpha particle ? Give a reason for your answer.

Ans : MAIN 2019

No, as it does not possess a helium nucleus.

37. A radioactive substance is oxidized. Will there be any change in the nature of its radioactivity ? Give a reason for your answer.

Ans : COMP 2016

No, radioactivity is not affected by any physical process.

38. Why do doctors wear lead aprons and spectacles while working near X-ray machine ?

Ans : MAIN 2015

X-rays do not penetrate the lead and thus doctor's body is not exposed to X-rays.

39. Name the particles given out during radioactive decay.

Ans : MAIN 2012

During radioactive decay, the particles given out are α (alpha) particles, β (beta) particles and γ (gamma) rays.

40. What do you mean by fall out from nuclear plants?

Ans : SQP 2008

Fall out is the residual radiation hazard from a nuclear explosion. These radiations fallout of the atmosphere after the explosion.

41. State one condition for the thermionic emission from a material.

Ans : COMP 2010

The work function or threshold energy of the material should be as low as possible.

42. How is the radioactivity of an element affected when it forms chemical compounds ?

Ans : MAIN 2000

In no way, Chemical bonds involve only orbital electrons, whereas radioactivity is a nuclear process.

NODIA

Ans : COMP 2005

Beta decay is a type of radioactive decay in which a proton is transformed into a neutron or vice versa inside the nucleus of the radioactive sample. We can say, during β-emission an electron is ejected from the atom of the radioactive substance. The electron is ejected from the: nucleus of the atom.
Thus (b) is correct option.

11. In fission of one uranium-235 nucleus, the loss in mass is 0.2 amu. Calculate the energy released.
(a) 156.4 MeV (b) 182.6 MeV
(c) 186.2 MeV (d) 189.1 MeV

Ans : MAIN 2022

In fission of U-235 nucleus, the loss of mass,

$$\Delta m = 0.2 \text{ amu}$$

Energy released, $\Delta E = \Delta mc^2$

$$= 0.2 \times 931.5 \text{ MeV}$$

$$= 186.2 \text{ MeV}$$

Thus (c) is correct option.

12. Heavy stable nuclei have more neutrons than protons. This is because of the fact that
(a) electrostatic force between protons are repulsive
(b) neutrons decay into protons through beta decay
(c) neutrons are heavier than protons
(d) nuclear forces between neutrons are weaker than that between protons

Ans : COMP 2011

Heavy stable nuclei have more neutrons than protons because protons are positively charged and repel each other. This repulsion force is more, so that an excess of neutrons are required to reduce this repulsion. Nuclear forces are strongest attractive forces between nucleons, whereas electrostatic force between protons is repulsive.
Thus (a) is correct option.

13. Which of the following radiation is most penetrating ?
(a) α-particles (b) β-particles
(c) X-rays (d) γ -radiation

Ans : SQP 2019

Gamma rays have the shortest wavelengths of all electromagnetic radiation, has the greatest penetrating power.
Thus (d) is correct option.

14. The radiations given out by radioactive elements :
(a) ionise the gases
(b) are affected by electrostatic and magnetic fields
(c) affect photographic plates
(d) all of these

Ans : MAIN 2007

The radiation given out by radioactive elements is Becquerel rays. Properties of Becquerel rays are:
1. They affect photographic plates.
2. They ionise the gas through which they pass.
3. They can penetrate through matter. The range of penetration depends upon the nature of the radioactive source and density of matter.
4. They are affected by electrostatic and magnetic fields.

Thus (d) is correct option.

15. When a nucleus in an atom undergoes a radioactive decay, then the electronic energy levels of the atom
(a) do not change for any type of radioactivity
(b) change for β-radioactivity but not for others
(c) change for α and β-radioactivity but not for γ-radioactivity
(d) change for α-radioactivity but not for others

Ans : SQP 2000

γ-decay occurs due to de-excitation of a nucleus and electronic energy levels involved is essentially in MeV.
Electronic energy levels have values only in eV.
Energy released per nucleon is 26.7 MeV.
Thus (c) is correct option.

16. When an element gives out high energy radiations on its own, the change which takes place is :
(a) nuclear change
(b) chemical change
(c) physical change
(d) none of these

Ans : MAIN 2021

In nuclear change, nuclear reactions occur and produce high energy. Nuclear reactions are processes in which one or more nuclides are produced from the collisions between two atomic nuclei or one atomic nucleus and a subatomic particle. The nuclides produced from nuclear reactions are different from the reacting nuclei (commonly referred to as the parent nuclei).
Thus (a) is correct option.

Click Here to Buy book on Amazon

3. A radioactive element is placed in an evacuated chamber. Then the rate of radioactive decay will
(a) Decrease
(b) Increase
(c) Remain unchanged
(d) Depend on the surrounding temperature

Ans : MAIN 2024

If a radioactive element is placed in an evacuated container, its rate of disintegration will remain constant since disintegration is a nuclear phenomenon that is unaffected by environmental conditions.
Thus (c) is correct option.

4. The heaviest nuclear radiation is
(a) X-radiation
(b) α-radiation
(c) γ-radiation
(d) β-radiation

Ans : SEM-II 2022

The heaviest nuclear radiation is the α-radiation. It is the helium nuclei.
Thus (b) is correct option.

5. To study the age of excavated material of archaeological significance we study the rate of decay of an isotope of
(a) Uranium (b) Cobalt
(c) Carbon (d) Chlorine

Ans : SEM-II 2022

The age of excavated material is determined by archaeologists with the help of an isotope of carbon (or carbon-14).
Thus (c) is correct option.

6. During α-emission :
(a) the mass number and atomic number of an atom decrease by 2 amu.
(b) the mass number decreases by 4 amu and atomic number remains unchanged
(c) the mass number decreases by 4 amu and atomic number decreases by 2 amu.
(d) the mass number remains unchanged, but atomic number decreases by 2 amu.

Ans : MAIN 2018

An alpha particle is a particle identical to a Helium-4 (He_2^4) atom and has 2 protons and 2 neutrons. Thus, when an atom releases an alpha particle, its mass number (M) decreases by 4 and its atomic number (Z) decreases by 2.
Thus (c) is correct option.

7. Which of the following radiation is most ionising ?
(a) β-particles (b) α-particles
(c) γ-radiation (d) X-rays

Ans : SQP 2010

Alpha particles have the highest ionisation power than the other two types of radiation owing to the fact that an α-particle is doubly ionised helium nucleus.
Thus (b) is correct option.

8. The atoms of same element having same atomic number, but different atomic masses are called :
(a) isotopes (b) isomers
(c) isobars (d) both (a) and (b)

Ans : COMP 2004

Atoms of the same element having the same atomic number but different mass are called isotopes. They have same number of protons and electrons but different number of neutrons.
Thus (a) is correct option.

9. The gravitational force between a H-atom and another particle of mass m will be given by Newton's law $F = G\frac{M \cdot m}{r^2}$, where r is in meter and

(a) $M = m_{\text{proton}} + m_{\text{electron}}$
(b) M is not relate to the mass of the hydrogen atom
(c) $M = m_{\text{proton}} + m_{\text{electron}} - \frac{|V|}{c^2}$
(d) $M = m_{\text{proton}} + m_{\text{electron}} - \frac{B}{c^2}(B = 13.6\text{ eV})$

($|V|$ = magnitude of the potential energy of electron in the H − atom)

Ans : SQP 2000

Given, $F = \frac{GMm}{r^2}$

M = effective mass of hydrogen atom

= mass of electron + mass of proton $- \frac{B}{c^2}$

Where,
B = binding energy of hydrogen atom = 13.6 eV.
Thus (d) is correct option.

10. During β-emission an electron is ejected from the atom of radioactive substance. The electron is ejected from the:
(a) the innermost orbit of atom
(b) the nucleus of the atom
(c) the outermost orbit of atom
(d) none of these

NODIA

22. A radioactive substances emits :
(a) simultaneously α, β and γ radiations
(b) X-rays and γ-rays
(c) α-radiations or β-radiations
(d) in the order of α, β and γ particles

Ans : MAIN 2003

Radioactive substances are atoms that decay naturally. They can give off alpha particles, beta particles and gamma radiation.
Thus (a) is correct option.

ASSERTION AND REASON

23. **Assertion :** Infrared radiations travel long distance through a dense fog and mist.
Reason : Infrared radiations undergoes minimal scattering in earth's atmosphere.
(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(b) Both Assertion and Reason are True and Reason is not the correct explanation of Assertion.
(c) Assertion is false but reason is true.
(d) Assertion is true but reason is false.

Ans : SQP 2025

Infrared radiations travel long distances through dense fog and mist as they undergo minimal scattering in earth's atmosphere.
Thus (b) is correct option.

24. **Assertion :** Out of α, β and γ radiation, α -particles have maximum penetrating power.
Reason : The α-particles are the heaviest amongst the three.
(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(b) Both Assertion and Reason are True and Reason is not the correct explanation of Assertion.
(c) Assertion is false but reason is true.
(d) Assertion is true but reason is false.

Ans :

Out of α β and γ radiation, γ-particles have maximum penetrating power. The penetrating power of a particle depends upon the energy carried by it, its mass and the charge carried by it. A particle with a greater energy can use it to force itself into another medium and thereby penetrate it. α-particles rapidly dissipates its energy as it moves through the medium and therefore its penetrating power is quite small.
Thus (c) is correct option.

25. **Assertion :** Isobars are the elements having same mass number but different atomic number.
Reason : Neutrons and protons are present inside nucleus.
(a) Both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) Both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) The Assertion is correct but Reason is incorrect.
(d) Both the Assertion and Reason are incorrect.

Ans :

By definition, isobars are elements having same mass number but different atomic number. Presence of neutron and proton inside nucleus has nothing to do with this definition.
Thus (b) is correct option.

26. **Assertion :** Separation of isotope is possible because of the difference in electron numbers of isotope.
Reason : Isotope of an element can be separated by using a mass spectrometer.
(a) Both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) Both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) Both the Assertion and Reason are incorrect.
(d) The Assertion is incorrect but the Reason is correct.

Ans :

Isotope of an element can be separated by using a mass spectrometer because isotopes have different atomic mass.
Thus (d) is correct option.

ONE MARK QUESTIONS

DIRECTION : Fill in the blanks :

27. During the emission of a beta particle, the ..... (mass/atomic) number remains the same.

NODIA

17. When four hydrogen nuclei combine to form a helium nucleus in the interior of sun, what amount of energy released per nucleon in this process ?

(a) 46.3 MeV (b) 26.7 MeV
(c) 18.5 MeV (d) 24.5 MeV

Ans : COMP 2002

When four hydrogen nuclei combine to form a helium nucleus in the interior of the sun, nuclear fusion takes place its a multi-step process in which hydrogen is fused into helium. The proton-proton (p,p) cycle by which this occurs is represented as

$4_1^1\text{H} + 2e^- \rightarrow {}_2^4\text{He} + 2v + 6v + 26.7$ MeV.

Hence, energy released per nucleon is 26.7 MeV.
Thus (b) is correct option.

18. The atoms of different elements having same mass number, but different atomic numbers are called :

(a) isotopes (b) isobars
(c) isomers (d) none of these

Ans : SQP 2014

The atoms of different elements with the same mass number, but different atomic numbers are called isobars.
Thus (b) is correct option.

19. The Sun radiates energy in all directions. The average radiation received on the earth surface from the Sun 1.4 kW/m^2. The average Earth-Sun distance 1.5×10^{11} m. The mass lost by the Sun per day is (1 day = 86400 s)

(a) 4.4×10^9 kg (b) 3.8×10^{14} kg
(c) 3.8×10^{12} kg (d) 7.6×10^{14} kg

Ans : COMP 2023

Energy radiated by Sun

$$= 1.4 \text{ kW/m}^2$$

$$= 1.4 \text{ kJ/sm}^2 \qquad \left(\text{Since}, P = \frac{\text{energy}}{\text{time}}\right)$$

$$= \frac{14}{\frac{1}{86400}} = \frac{1.4 \times 864000}{\text{day } m^2}\text{kJ}$$

Total energy radiated per day

$$E = \frac{4\pi \times (1.5 \times 10^{11})^2 \times 1.4 \times 86400}{1}$$

$$= \frac{\text{kJ}}{\text{day}}$$

Hence, We have,

$$E = mc^2$$

$$m = \frac{E}{c^2}$$

$$= \frac{4\pi \times (1.5 \times 10^{11})^2 \times 1.4 \times 86400 \times 10^3}{(3 \times 10^8)^2}$$

$$= 3.8 \times 10^{14} \text{ kg}$$

Thus (b) is correct option.

20. During β-emmision :

(a) the mass number remains unchanged, but atomic number decreases by 1 amu.
(b) the mass number increases by 1 amu, but atomic number remains same
(c) the mass number remains unchanged, but atomic number increases by 1 amu.
(d) the mass number and atomic number decrease by 1 amu.

Ans : MAIN 2013

During beta emission a neutron gets converted into a proton and hence total number of protons and neutrons remains constant i.e., mass number remains but atomic number increases by 1 amu.
Thus (c) is correct option.

21. A stationary radioactive nucleus of mass 210 units disintegrates into an α-particle of mass 4 units and residual nucleus of mass 206 units. If the kinetic energy of the α-particle is E, then the kinetic energy of the residual nucleus is

(a) $(\frac{103}{105})E$ (b) $(\frac{2}{105})E$
(c) $(\frac{2}{105})E$ (d) $(\frac{2}{103})E$

Ans : COMP 2010

Momentum remains constant,

$$K = \frac{p^2}{2m}$$

$$K \propto \frac{1}{m}$$

Now, for α-particle,

$$KE = K_n$$

$$\text{Mass} = m_\alpha = 4$$

For residual nucleus,

$$KE = K_\alpha$$

$$\text{Mass } m_n = 210 - 4 = 206$$

$$\frac{K_n}{K_\alpha} = \frac{m_\alpha}{m_n}$$

$$= \frac{4}{206} = \frac{2}{103}$$

$$K_n = \left(\frac{2}{103}\right)K_\alpha$$

Given, energy of α-particle is E

Hence, $$K_n = \left(\frac{2}{103}\right)E$$

Thus (b) is correct option.

Downloaded from www.pdf.tube

43. An α-particle absorbs an electron. What does it change to ?

Ans : SQP 2006

An α-particle after absorbing an electron becomes helium ion (He^+).

44. State one use of radioisotopes.

Ans : COMP 2005

They are used to study the function of fertilisers for different plants. They are also used in medical diagnosis and medical therapy.

45. Name the particle given out during radioactive decay.

Ans : SQP 2001

Either α, β and γ.

46. A radioactive substance is oxidised. What change would you expect to take place in the nature of its radioactivity ? Give a reason for your answer.

Ans : COMP 2000

When a radioactive nucleus is oxidised there will be no change in the nature of radioactivity. This is because chemical changes do not affect radioactivity. Radioactivity is a nuclear phenomenon.

47. Define nuclear fission.

Ans : SQP 2019

It is the splitting of a heavy nucleus into two or more smaller nuclei with the release of tremendous energy.

48. Why is a nuclear fusion reaction called a thermo nuclear reaction ?

Ans : MAIN 2019

Because this occurs at a very high temperature.

49. Why is a cathode ray tube evacuated to a low pressure?

Ans : SQP 2011

So that the electrons emitted do not collide with the gas molecules.

50. What happens if the negative potential is changed on a grid ?

Ans : MAIN 2015

The change in negative potential changes the number of electron striking the screen which in turn changes the brightness of the screen.

51. The nucleus ${}^{202}_{84}X$ emits an alpha particle and forms the nucleus Y. Represent this change in the form of an equation.

Ans : SQP 2011

$${}^{202}_{84}X \longrightarrow {}^{198}_{82}Y + {}^{4}_{2}\text{He}$$

52. What changes will take place in the mass number and atomic number of the nucleus Y if it emits gamma radiations ?

Ans : COMP 2011

If a nucleus emits gamma radiation, no change will take place in the mass number and atomic number.

53. What is the name given to atoms of a substance which have the same atomic number but different mass numbers ?

Ans : COMP 2009

Isotopes.

54. What is the difference in the atomic structures of such atoms ?

Ans : SQP 2009

The nuclei of such atoms have different number of neutrons but have same number of protons.

55. Name the radiations which are absorbed by greenhouse gases in the earth's atmosphere.

Ans : MAIN 2017

Infrared.

56. A radiation X is focused by a particular device on the bulb of a thermometer and mercury in the thermometer shows a rapid increase. Name the radiation X.

Ans : MAIN 2017

Infrared.

57. Name two factors on which the heat energy liberated by a body depends.

Ans : COMP 2017

Temperature and surface area.

58. What are free electrons ?

Ans : COMP 2017

These are the electrons which are not bound to the nucleus and are free to move in the metal.

NODIA

59. Why do they not leave the metal surface on their own ?

Ans : SQP 2017

Because it finds itself being pulled by the positive charge left behind as it becomes.

60. How can they be made to leave the metal surface? (State any two ways)

Ans : MAIN 2017

They can be made to leave the metal surface by (a) Thermionic emission (heating the metal surface) (b) Photoelectric emission (By shining a radiation of sufficient frequency on the metal surface).

61. State two characteristics of a good thermion emitter.

Ans : MAIN 2017

(i) Should have high melting point and
(ii) Should have low value of work function.

62. State two factors upon which the rate of emission of thermions depends.

Ans : SQP 2017

(i) The nature of the metal and
(ii) Temperature of the metal surface.

63. When does the nucleus of an atom tend to be radioactive ?

Ans : COMP 2017

The nucleus tends to be radioactive when it becomes unstable.

64. Represent the change in the nucleus of a radioactive element when a β particle is emitted.

Ans : COMP 2016

The change is as shown

$$^{A}_{Z}P \longrightarrow {}^{A}_{A+1}D + {}^{0}_{-1}e$$

65. What is the name given to elements with same mass number and different atomic number?

Ans : MAIN 2016

Isobars.

66. Under which conditions does the nucleus of an atom tend to be radioactive ?

Ans : SQP 2016

When the nucleus is unstable.

67. What is meant by Radioactivity ?

Ans : MAIN 2013

Radioactivity is the self spontaneous disintegration of a heavy nucleus into α, β and γ radiations in order to attain stability.

68. What is meant by nuclear waste ?

Ans : MAIN 2013

The radioactive material after its use is known as nuclear waste.

69. Suggest one effective way for the safe disposal of nuclear waste.

Ans : SQP 2013

The nuclear waste should be kept in thick casks (thick lead containers) and then they must be buried in the specially constructed deep underground stores or in useless mines and these mines should be sealed after storing casks.

70. What is the value of the speed of gamma radiations in air or vacuum?

Ans : COMP 2012

The speed of gamma radiations in air or vacuum is $3 \times 10^{8}\,\text{m/s}$.

71. Name a material which exhibits fluorescence when cathode rays fall on it.

Ans : COMP 2012

Barium platinocyanide.

72. What are isobars ?

Ans : MAIN 2018

Elements having same mass number but different atomic number.

73. Give one example of isobars.

Ans : SQP 2018

^{40}S, ^{40}Cl, ^{40}Ar, ^{40}K and ^{40}Ca.

74. An atomic nucleus denoted by $^{A}_{Z}X$ emits an alpha particle. Write an equation to show the formation of the daughter product.

Ans : COMP 2018

The equation is as shown below :

$$^{A}_{Z}X \longrightarrow {}^{A-4}_{Z-2}D + {}^{4}_{2}\text{He}$$

75. Which part of the atom undergoes a change in the process of radioactive decay ?

Click Here to Buy book on Amazon

Ans : MAIN 2000

The nucleus of the atom undergoes a change in the process of radioactive decay.

76. What are isotopes ? Give examples.

Ans : MAIN 2007

The atoms of same element which have same atomic number but different mass number are called isotopes. Examples : Protium, Deuterium, and Tritium are the isotopes of hydrogen.

77. What is the origin of X-rays and γ-radiations ?

Ans : COMP 2013

X-rays are produced due to the transition of electrons in the inner orbits of an atom, while the γ-radiations are given out from the nucleus.

78. What do you mean by charge independent nature of nuclear forces?

Ans : MAIN 2019

Nuclear forces do not depend on the charges of the nucleons.

79. State Einstein's mass-energy equivalence relation.

Ans : SQP 2001

According to mass energy equivalence, mass and energy are interchangeable.
The Einstein's mass-energy relation is

$$E = mc^2$$

where m is mass converted into energy, c is the speed of light and E is the energy in joules.

80. Select the pairs of isobars and isotopes from the following nuclei :
${}^{14}_{6}\text{C},\ {}^{13}_{7}\text{N},\ {}^{14}_{7}\text{N},\ {}^{16}_{8}\text{O},\ {}^{13}_{6}\text{C},\ {}^{30}_{15}\text{P},\ {}^{17}_{8}\text{O},\ {}^{24}_{11}\text{Na},\ {}^{31}_{15}\text{P},$
${}^{18}_{2}\text{O},\ {}^{22}_{11}\text{Na},\ {}^{23}_{11}\text{Na},\ {}^{23}_{12}\text{Mg}$

Ans : SQP 2011

Isotopes:
$({}^{13}_{6}\text{C}, {}^{14}_{6}\text{C}), ({}^{13}_{7}\text{N}, {}^{14}_{7}\text{N}), ({}^{16}_{8}\text{O}, {}^{17}_{8}\text{O}, {}^{18}_{8}\text{O}), ({}^{30}_{15}\text{P}\,{}^{31}_{15}\text{P}),$
$({}^{22}_{11}\text{Na}, {}^{23}_{11}\text{Na}, {}^{24}_{11}\text{Na})$

Isobars: $({}^{13}_{6}\text{C}, {}^{13}_{7}\text{N}), ({}^{23}_{11}\text{Na}, {}^{23}_{12}\text{Mg}), ({}^{14}_{6}\text{C}, {}^{14}_{7}\text{N})$

81. A fusion reaction is represented as follows :

$${}^{2}_{1}\text{H} + {}^{2}_{1}\text{H} \longrightarrow {}^{4}_{2}\text{He} + x$$

Identify x.

Ans : MAIN 2005

Here x represents the energy produced by fusion of two ${}^{2}_{1}\text{H}$ atoms [This is in fact reaction of hydrogen bomb and x is the energy produced by it].

82. Out of alpha, beta and gamma-radiations, which is the most dangerous to human beings ? Why ?

Ans : SQP 2010

Gamma radiation, because of high penetrating power.

83. Why are α-particles not used in radio therapy ?

Ans : SQP 2006

Alpha particles have very small penetrating power and hence they cannot enter the skin.

84. Which type of harmful radiations are emitted by nuclear wastes ?

Ans : MAIN 2018

Beta particles and gamma rays.

85. Which nuclear radiation has the least penetrating power ?

Ans : COMP 2002

Alpha particles have least penetrating power because they have greater mass and therefore, lesser velocity.

86. Why are gamma rays emitted only in nuclear processes and not in orbital electron transitions ?

Ans : SQP 2012

The energy of gamma rays is of the order of MeV. Energies of this magnitude occur in nuclear processes but not in orbital electron transition.

87. What do you mean by a radiograph ?

Ans : COMP 2021

Radiograph is the photograph of the bones inside the body on a photographic film.

88. What do you mean by tracer technique ?

Ans : COMP 2009

Tracer technique is a process of adding a very small quantity of radio-isotope to the same element. It is called labelling and the radio-isotope used is called isotopic tracer. The technique of using radioactive tracers to study a certain phenomenon is called tracer technique.

89. Name the radioactive radiations emitted from a radioactive element.

Ans : COMP 2019

α, β and γ rays.

NODIA

90. An element X changes to another element Y with the emission of beta particle. Write down the equation showing changes in the nucleus. Take the proton number and mass number of X, as Z and A respectively.

Ans : MAIN 2020

$$^{A}_{Z}X \xrightarrow[\text{emission}]{\beta-\text{particle}} {}^{A}_{Z+1}Y + \underset{(\beta-\text{particle})}{{}^{0}_{-1}e}$$

91. What is the use of a photograph taken with a metallic plate in front of the screen ?

Ans : MAIN 2001

A photograph taken with a metallic plate in front of the screen helps us to detect the flaws and cracks in metal casting.

92. A nucleus of an element X which has a symbol $^{235}_{92}X$ emits α and then a β-radiation. The final nucleus in $^{b}_{a}Y$. Find 'a' and 'b'.

Ans : SQP 2004

$$^{235}_{92}X \xrightarrow[\alpha-\text{radiation}]{^{4}_{2}\text{He}} {}^{231}_{90}Y \xrightarrow[\beta-\text{radiation}]{^{0}_{-1}e} {}^{231}_{91}Y$$

$$a = 91 \text{ and } b = 231$$

93. Who confirmed the first ever nuclear reaction?

Ans : SQP 2015

Blackest in 1925 established experimentally that α-particles emitted by radium are captured by the nitrogen nuclei and protons are emitted. The reaction is as follows :

$$^{14}_{7}\text{N} + {}^{2}_{4}\text{He} \longrightarrow {}^{17}_{8}\text{O} + {}^{1}_{1}\text{H}$$

94. Name one device in which the cathode ray tube is used.

Ans : SQP 2011

Television/computer monitor.

95. What is the importance of boron and cadmium rods in a nuclear reactor ?

Ans : COMP 2011

Cadmium and boron rods absorb excess of neutrons and control the chain reaction.

96. What are isobars ? Give examples.

Ans : MAIN 2017

The atoms of different elements which have the same mass number but different atomic numbers are called isobars. Examples: Sodium, Magnesium.

97. Which one is unstable amongst proton, neutron, electron and α-particle?

Ans : MAIN 2017

Neutron.

98. What is the difference between an electron and a β-particle?

Ans : COMP 2011

Basically β-particle and an electron has no difference. β-particle is the name given to an electron emitted from the nucleus.

99. State the effects of fall-out from a nuclear explosion.

Ans : SQP 2017

Fall-out from a nuclear explosion leads to the contamination of the earth and simultaneously food chain.

100. Name the technique used to estimate the age of very old trees, plants, wood and other such specimens. Name the isotope that forms the basis of this technique.

Ans : COMP 2017

Carbon dating, Isotope C-14

101. A certain radioactive nucleus emits a particle that leaves its mass unchanged but increases its atomic number by one. Identify the particle and write its symbol.

Ans : MAIN 2021

β-particle and it is represented by the symbol $^{0}_{-1}e$

102. What do you mean by nuclear science?

Ans : COMP 2020

Nuclear science is the whole subject concerned with the nuclear transformations.

103. What type of waves (electromagnetic/mechanical) are X-rays ?

Ans : SQP 2009

X-rays are electromagnetic waves of short wavelength.

104. Name two materials which are used as a target in X-ray tube.

Ans : COMP 2008

Tungsten, Molybdenum.

Downloaded from www.pdf.tube

105. How is the radioactivity of an element affected when it undergoes a chemical change to form a chemical compound?

Ans : SQP 2010

No effect

106. Name two important discoveries led by 'nuclear reactions'.

Ans : MAIN 2017

Nuclear reactions led to many interesting new discoveries including that of nuclear fission and fusion.

107. When does the nucleus of an atom become radioactive?

Ans : MAIN 2019

When the atomic number of the atom is greater than 82 the nucleus of the atom becomes radioactive.

108. Name the product of nuclear fission which is utilized to bring about further fission of $^{235}_{92}\mathrm{U}$

Ans : COMP 2010

Neutron

109. Mention one use and one harmful effect of radioactivity.

Ans : COMP 2020

Uses : To treat cancer, carbon dating.
Harmful effect: Kill the living tissues and causes radiation burns.

110. Give one source of background radiation.

Ans : MAIN 2011

Cosmic rays from high altitude/radiations from radioactive isotopes from the earth's crust.

111. Describe a common use of X-rays.

Ans : MAIN 2009

A common use of X-rays is medical imaging or security scanning at airports etc. or finding defects in welding.

112. State a precaution taken by those who work with X-rays.

Ans : MAIN 2016

Use of shielding or monitor exposure.

TWO MARKS QUESTIONS

113. (a) Name the radiations that are emitted during the decay of a nucleus, which has highest penetrating power?
(b) Does the emission of the above-mentioned radiation result in a change in the mass number?

Ans : SQP 2025

(a) gamma / γ
(b) No.

114. In the following atoms, which one is a radioisotope? Give one use of this isotope. O^{16}, C^{14}, N^{14}, He^4

Ans : MAIN 2024

C^{14} is a radioisotope because of the instability of the nucleus. It's used for carbon dating.

115. Copy and complete the nuclear reaction by filling in the blanks.

$$_{92}\mathrm{U}^{235} + {}_{0}\mathrm{n}^{1} \longrightarrow {}_{56}\mathrm{Ba}^{\cdots} + {}_{\cdots}\mathrm{Kr}^{92} + 3\,{}_{0}\mathrm{n}^{1}$$

Ans : MAIN 2024

$$_{92}\mathrm{U}^{235} + {}_{0}\mathrm{n}^{1} \rightarrow {}_{46}\mathrm{Ba}^{141} + {}_{36}\mathrm{Kr}^{92} + 3{}_{0}\mathrm{n}^{1}$$

116. A nucleus ${}_{84}X^{202}$ of an element emits and alpha particle followed by a beta particle. The final nucleus is ${}_{a}Y^{b}$. Find a and b.

Ans : COMP 2020

The scheme of decay is ${}_{84}X^{202} \xrightarrow{\alpha} {}_{82}Z^{198} \xrightarrow{\beta} {}_{83}Y^{198}$, therefore, $a = 83$, $b = 198$.

117. An element $^{A}_{Z}\mathrm{S}$ decays to $^{222}_{85}\mathrm{R}$ after emitting 2 α-particles and 1 β-particle. Find the atomic number and atomic mass of the element S.

Ans : COMP 2016

$$^{A}_{Z}\mathrm{S} \xrightarrow{-2\alpha \text{ and } -\beta} {}^{222}_{85}\mathrm{R}$$

$$^{A}_{Z}\mathrm{S} \xrightarrow{-\alpha} {}^{(A-4)}_{(Z-2)}X_1 \xrightarrow{-\alpha} {}^{[(A-4)-4]}_{[(Z-2)-2]}X_2 \xrightarrow{-\beta} {}^{[(A-4)-4]}_{[(Z-2)-2\}+1]}X_3$$

According to the question $^{A-8}_{Z-3}X_3 = {}^{222}_{85}R$
After comparing, we get

$$Z - 3 = 85$$
$$Z = 88$$
$$A - 8 = 222$$
$$A = 230$$

NODIA

charged and holds the emitted electrons close to it. These thermionics surround the cathode in the form a cloud. It stops the further emission of thermionics and hence no current flows. This collection of a large number of electrons near the cathode is called the space charge.

153. A radioactive element ${}^{A}_{Z}X$ first emits a β particle and then an alpha particle and the resulting nucleus can be represented ${}^{P}_{Q}Y$. What are the values of P and Q in terms of A and Z ?

Ans : MAIN 2005

${}^{A}_{Z}X \xrightarrow{\beta-\text{particle}}$ nucleus of some other element say ${}^{A}_{Z+1}U$ having the same mass number but the atomic number increases by 1. On further emission of an alpha particle (${}^{4}_{2}\text{He}$)

$${}^{A}_{Z+1}U \xrightarrow{\alpha-\text{particle}} {}^{A-4}_{Z-1}Y$$

Hence the values of P and Q are respectively equal to

$$P = A - 4,\ Q = Z - 1$$

154. A radioactive substance emits either an alpha or a beta particle only. Then why is radioactive radiations divided into three parts by applying electric or magnetic fields ?

Ans : COMP 2010

The radioactive decay occurs in series where daughter nucleus gives rise to grand daughter and so on. Some of them are alpha emitters while others are beta emitters. If after the alpha or beta emission, the nucleus is left in the excited state, it may emit a gamma ray. Therefore, the given nucleus gives out alpha, beta and gamma rays.

155. What is carbon-14-dating ?

Ans : SQP 2010

Carbon-14 is an isotope of carbon found in the atmosphere due to bombardment of ${}^{14}_{7}\text{N}$ with a neutron.

$${}^{14}_{7}\text{N} + {}^{1}_{0}\text{n} \longrightarrow {}^{14}_{6}\text{C} + {}^{1}_{1}\text{H}\ (\text{proton})$$

Living plants also absorb carbon dioxide from the atmosphere which contains a constant quantity of C-14. When a plant dies and begins to decay the C-14 present in it now begins to decay by β (beta) emission. The counting rate of β-emission from a sample of dead matter such as wood, charcoal etc. is found to be less than the counting rate of β-emission when it (plant) was alive. By measuring the count rate, the age of the specimen can be found.

156. State three properties that are common to and shown by both beta rays and cathode rays.

Ans : SQP 2010

Properties that are common to and shown by both beta rays and cathode rays are :

(i) deflected by electric and magnetic fields.
(ii) ionise the gas through which they pass.
(iii) penetrate through a thin sheet of matter.

157. Why is the energy distribution of beta decay continuous ?

Ans : COMP 2000

The phenomenon of beta decay arises due to the conversion of a neutron in the nucleus into a proton, electron and an anti-neutrino. Because the energy available in beta decay is shared by the electron and the anti-neutrino in all possible ratios as they come out of the nucleus the beta ray spectrum is continuous in nature.

158. Mention four points of discovery of neutrons.

Ans : COMP 2004

The following are the four points of discovery of neutrons :

(i) Neutrons lead to the development of structure of nucleus and nuclear physics.
(ii) Neutrons are used to produce radio-isotopes widely used in the field of medicine, agriculture and industry, etc.
(iii) Neutrons are used to cure cancer.
(iv) Thermal neutrons (low energy neutrons) are used to carry out nuclear fission.

159. What are nuclear forces ? What kind of force exist (if any) between the constituents of nucleus ?

Ans : COMP 2004

Nuclear forces are the strong forces of attraction which hold together the nucleons (neutrons + protons) in the nucleus of an atom despite strong electrostatic forces of repulsion between protons. In between the constituents of nucleus, nuclear forces act between proton and proton, proton and neutron, and neutron and neutron.

160. Mention two common properties of gamma radiations and visible light.

Ans : SQP 2018

(i) Gamma radiations and visible light are electromagnetic waves and hence do not require any material medium for their

Click Here to Buy book on Amazon

126. Which of the radioactive radiations
(a) can cause severe genetical disorders ?
(b) are deflected by an electric field ?

Ans : MAIN 2013

(a) Gamma radiations can cause severe genetical disorders.
(b) α and β radiations are deflected by an electric field.

127. Name the three main parts of a Cathode Ray Tube.

Ans : COMP 2013

The main three parts of a cathode ray tube are as follows:
(i) Electron gun.
(ii) Deflecting plates.
(iii) Fluorescent screen.

128. What will an alpha particle change into when it absorbs (i) one electron, (ii) two electrons ?

Ans : SQP 2007

Alpha particle are nuclei of helium He^4. When it absorbs electron it will become a singly charged helium atom. On absorbing two electrons it will become a helium atoms.

129. Give one difference between a chemical change and a nuclear change.

Ans : SQP 2004

A chemical change is an extra nuclear phenomenon. It is concerned with the electrons alone. A nuclear reaction involves the nucleus and its constituents. In this reaction new elements are produced.

130. State briefly two uses of a cathode ray tube.

Ans : COMP 2002

Two uses of cathode ray tube are :
(i) Used in television.
(ii) Used to investigate the varying potential difference.

131. Show by equations, the effect on the proton number Z and the mass number A of the parent nucleus brought about by the two types of radioactive decay.

Ans : MAIN 2001

During beta decay, the following equation is followed:

$$^{A}_{Z}P \xrightarrow{\alpha} {}^{A}_{Z+1}D + {}^{0}_{-1}e$$

During alpha decay, the following equation is followed:

$$^{A}_{Z}X \xrightarrow{\beta} {}^{A-4}_{Z-2}D + {}^{4}_{2}\text{He}$$

132. In the reaction $^{27}_{12}\text{Mg} \xrightarrow{\beta} \text{Al} \xrightarrow{\gamma} ---$
(i) $^{27}_{12}\text{Mg}$ emits a beta particle and is transformed into aluminium. Write the mass number and the atomic number of Aluminium.
(ii) Aluminium emits a gamma ray. What is the resulting nucleus ?

Ans : MAIN 2001

(i) The reaction is as shown :

$$^{27}_{12}\text{Mg} \xrightarrow{\beta} {}^{27}_{13}\text{Al} \xrightarrow{\gamma} {}^{27}_{13}\text{Al}$$

Therefore, the mass number of aluminium is 27 and its atomic number is 13.
(ii) The resulting nucleus is still an aluminium nucleus.

133. In β-emission from a radioactive substance an electron is ejected. Where from does this electron come from ?

Ans : SQP 2006

The electron emitted during β-decay is not the orbital electron. It is produced in the nucleus at time of emission according to the following reaction.

$$^{1}_{0}n \longrightarrow {}^{1}_{1}\text{H} + {}^{0}_{-1}e + \bar{\nu}$$

134. State two safety precautions you would take while handling radioactive substances.

Ans : SQP 2006

(i) The user should wear a protective lead jacket and wear protective glasses.
(ii) The user should use protective lead gloves on his/her hands.

135. Two important nuclear reactions are described incompletely by the following equations :

$$^{27}_{13}\text{Al} + {}^{4}_{2}\text{He} \longrightarrow {}^{30}_{14}\text{Si} + ? \text{ and}$$

$$^{39}_{19}\text{K} + ? \longrightarrow {}^{42}_{20}\text{Ca} + {}^{1}_{1}\text{H}$$

Fill in the gaps in these equations by employing the conservation of the masses and atomic number of the reacting species and products.

Ans : MAIN 2009

$$^{27}_{13}\text{Al} + {}^{4}_{2}\text{He} \longrightarrow {}^{30}_{14}\text{Si} + {}^{1}_{1}\text{H}$$

$$^{39}_{19}\text{K} + {}^{4}_{2}\text{He} \longrightarrow {}^{42}_{20}\text{Ca} + {}^{1}_{1}\text{H}$$

136. What is the nature of α, β and γ-radiations ?

Downloaded from www.pdf.tube

118. A radioactive substance is oxidized. Will there be any change in the nature of its radioactivity ? Give a reason for your answer.

Ans : SQP 2010

On oxidizing the radioactive substance, there will be no change in the nature of its radioactivity. As this is a chemical change which does not affect the nature of the radioactivity, whereas radioactivity is a nuclear phenomenon.

119. Complete the following nuclear changes :

(i) $^{24}_{11}\text{Na} \longrightarrow {}^{\cdots}_{\cdots}\text{Mg} + {}^{0}_{-1}\beta$

(ii) $^{238}_{92}\text{U} \longrightarrow {}^{234}_{90}\text{Th} + {}^{4}_{2}\text{He} + \text{Energy}$

Ans : MAIN 2010

(i) $^{24}_{11}\text{Na} \longrightarrow {}^{24}_{12}\text{Mg} + {}^{0}_{-1}\beta$

(ii) $^{238}_{92}\text{U} \longrightarrow {}^{234}_{90}\text{Th} + {}^{4}_{2}\text{He} + \text{Energy}$

120. (i) Which radiation produces maximum biological damage ?

(ii) What happens to the atomic number of an element when the radiation named by you in part (i) above, are emitted ?

Ans : COMP 2010

(i) γ-radiation produces maximum biological damage as this radiation can easily pass through the human body.

(ii) No change will take place in an atomic number of an element.

121. Arrange α, β and γ rays in ascending order with respect to their :

(i) Penetrating power.

(ii) Ionizing power.

(iii) Biological effect.

Ans : MAIN 2016

(i) Alpha, Beta and Gamma.

(ii) Gamma, Beta and Alpha.

(iii) Gamma, Beta and Alpha.

122. A mixture of radioactive substances gives off three types of radiations.

(i) Name the radiation which travels with speed of light.

(ii) Name the radiation which has the highest ionising power.

Ans : COMP 2011

(i) γ-rays

(ii) Alpha particle

123. Give any two important sources of background radiation.

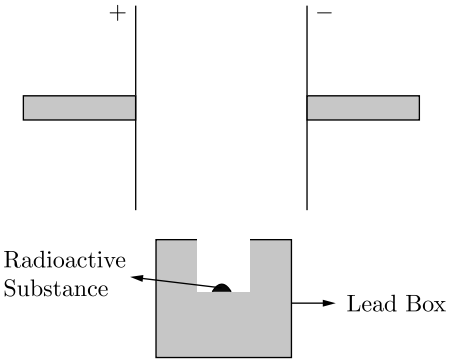
Ans : SQP 2012

The following are the two important sources of background radiation:

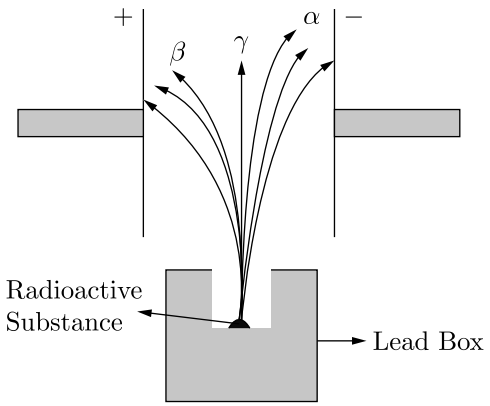
(i) Cosmic radiations from the space.

(ii) Rocks containing traces of radioactive substances in the earth.

124. Complete the diagram as given by drawing the deflection of radioactive radiations in an electric field.



Ans : MAIN 2015



125. State any two precautions to be taken while handling radioactive substances.

Ans : MAIN 2015

The following precautions should be taken while handling any radioactive source :

(i) The nuclear (or radioactive) material must be kept in thick lead containers with narrow mouth and plugged with thick lead corks.

(ii) A periodic compulsory medical check-up should be done so that if any person is found to be over exposed to these radiations, he/she should be immediately withdrawn for proper treatment.

NODIA

(a) Alpha (α)
(b) Beta (β) and
(c) Gamma (γ).

(ii) All the above radiations are not emitted in a single radioactive decay. There will be either an α-emission or β-emission, which may be accompanied by γ-emission.

144. Write four main sources of creation of nuclear waste.

Ans : COMP 2008

The following are the four main sources of creation of nuclear waste :
(i) Waste created from dismantling of nuclear weapons.
(ii) Waste produced by industrial and medical sectors.
(iii) Spent fuel from nuclear reactors.
(iv) Waste left after reprocessing of spent fuel.

145. Arrange α, β and γ-rays in ascending order with respect to their (i) penetrating power, (ii) ionising power and (iii) biological effect.

Ans : SQP 2007

(i) α, β, γ
(ii) γ, β, α
(iii) α, β, γ

146. Define the terms : (i) atomic number and (ii) mass number. Are these quantities conserved in a radioactive β-decay ?

Ans : SQP 2012

The atomic number of an element is the number of protons in its nucleus. The mass number of an element is the total number of nucleons in its nucleus, i.e., the sum of the number of protons and the number of neutrons in it. Mass number is conserved but atomic number is not conserved. The atomic number increases by one.

147. What are α, β and γ radiations composed of ?

Ans : MAIN 2020

α-rays are the helium nuclei, i.e. helium atoms having lost orbital electrons. The mass of α -particles 6.645×10^{-27} kg and the charge is 3.2×10^{-19} C.
β-rays are composed of stream of electrons with negative charge of 1.6×10^{-19} C and mass of 9.1×10^{-31} kg.
γ-rays are the electromagnetic radiations of short wavelength of the order of 0.1 Å to 5 Å. They are photons of rest mass zero. They travel with velocity of light.

148. In heavy nuclei, number of neutrons is greater than the number of protons. Why ?

Ans : COMP 2018

In heavy nuclei, the number of protons is very high. As a result of this, electrostatic repulsive forces between them also become very high. The attraction due to nuclear forces cannot contain the protons together in the nucleus. The presence of large number of neutrons separates the protons, thereby weakening the repulsion between them.

149. Is it possible for hydrogen atom isotope to emit alpha particle ? Explain.

Ans : COMP 2001

No, it is not possible. It is because alpha particle consists of two protons and two neutrons. However, none of the isotopes of hydrogen has the same number or more of protons and neutrons in its nuclei. Thus, they cannot emit alpha particle.

150. State whether following nuclear disintegrations are allowed or not ? (Star indicates excited state).
(i) ${}^{*}_{Z}X^{A} \longrightarrow {}_{Z}X^{A} + \gamma$ -rays
(ii) ${}_{Z}X^{A} \longrightarrow {}^{*}_{Z-2}X^{A} + {}_{2}\mathrm{He}^{4}$.

Ans : SQP 2000

(i) The reaction is possible as it obeys the law of conservation of mass and charge.
(ii) This reaction is not possible as it does not obey the law of conservation of mass and charge.

151. Give reasons for the following :
(i) Beta particles are deviated to a greater extent in a magnetic field than alpha particles.
(ii) Gamma rays are not deflected in an electric field.

Ans : SQP 2000

(i) Beta particles have a negligible mass as compared to alpha particles, so they are easily attracted and show a greater deflection.
(ii) Gamma rays carry no charge so they are not deflected.

152. What is space charge ?

Ans : COMP 2005

In the absence of an anode (plate) if the filament circuit is switched on, the emission of electron takes pace. As a result, the cathode becomes positively

Click Here to Buy book on Amazon

191. Do alpha and beta decay cause a change of element, called transmutation ?

Ans : COMP 2019

Yes, in alpha decay, the element moves back by two places on the periodic table. In beta decay, the element moves forward one place on the periodic table.

192. Explain what changes take place within the nuclei, when beta particles are emitted by a radioactive substance ?

Ans : COMP 2019

When beta decay takes place the following reaction is followed :

$$^{A}_{Z}P \longrightarrow {}_{Z+1}{}^{A}D + {}^{0}_{-1}e$$

Thus, during this decay the mass number remains same whereas the atomic number increases by one.

193. In nuclear reaction $^{27}_{12}\text{Mg} \xrightarrow{-\beta} \text{Al} \xrightarrow{-\gamma}$

(a) $^{27}_{12}\text{Mg}$ emits a β-particle and is transformed to aluminium. What is the mass number and the atomic number of aluminium?

(b) Aluminium emits a γ ray. What is the resulting nucleus?

Ans : MAIN 2022

(a) $^{27}_{12}\text{Mg} \xrightarrow{-\beta} {}^{27}_{13}\text{Al}$

Mass number of aluminium = 27
Atomic number of aluminium = 13

(b) $^{27}_{13}\text{Al} \xrightarrow{-\gamma}$ No change in the nucleus

194. What is meant by free electrons?

Ans : SQP 2020

The valence electrons of an atom are bound to the nucleus with a very small force and as such they get dislodged from their orbit very easily. These dislodged electrons move about freely within the substance and are known as free electrons.

195. Why are they generally not able to leave the metallic surface?

Ans : SQP 2022

At ordinary temperature, the free electrons in metals cannot leave the surface of a metal due to certain attractive surface forces. These electrons possess a certain amount of energy which is insufficient for electrons to leave the metal surface.

196. Suggest one way by which these electrons could be made to leave the metal surface.

Ans : COMP 2022

These electrons can leave the metal surface by gaining energy from any external source such as heat energy, light energy, by applying strong electric field, etc.

THREE MARKS QUESTIONS

NODIA

197. A radioactive nucleus X emits an alpha particle followed by two beta particles to form nucleus Y.

(a) With respect to the element X, where would you position the element Y in the periodic table?

(b) What is the general name of the elements X and Y?

(c) If the atomic number of Y is 80 then what is the atomic number of X?

Ans : SQP 2025

(a) At the same place

(b) Isotopes.

(c) 80

198. Below is an incomplete table showing the arrangement of electromagnetic spectrum in the increasing order of their wavelength. Complete the table.

Gamma ray	X-ray	U V rays	Visible rays	Infra-red	A	Radio

(a) Identify the radiation A.

(b) Name the radiation used to detect fracture in hones.

(c) Name one property common to both A and Radio waves.

Ans : MAIN 2024

(a) Microwave

(b) X-rays

(c) Both have same speed in vacuum

199. A nucleus $^{24}_{11}\text{Na}$ emits a beta particle to change into Magnesium (Mg).

(i) Write the symbolic equation for the process.

(ii) What are numbers 24 and 11 called ?

(iii) What is the general name of $^{24}_{12}\text{Mg}$ with respect to $^{24}_{11}\text{Na}$?

Ans : COMP 2014

propagation.
(ii) These waves travel in vacuum with the speed of light (i.e. $3 \times 10^8\ \mathrm{m\,s^{-1}}$).
(iii) These waves are transverse in nature. (Any two)

161. Complete the following nuclear reactions successfully demonstrated with the following energetic projectiles: α-particles, protons, γ-rays, neutrons.
(a) ${}^{24}_{12}\mathrm{Mg} + _____ \longrightarrow {}^{23}_{11}\mathrm{Na} + {}^{1}_{1}\mathrm{H}$
(b) ${}^{27}_{13}\mathrm{Al} + {}^{1}_{1}\mathrm{H} \longrightarrow _____ + {}^{1}_{0}n$

Ans : SQP 2018

(a) γ-radiation
(b) ${}^{27}_{14}\mathrm{Si}$

162. How are X-rays and γ-rays produced?

Ans : COMP 2018

X-rays are produced when fast moving electrons strike a metal of high atomic weight and high melting point.
γ-rays are produced from nuclei of substances either by artificial or natural disintegrations.

163. (a) What is the name given to atoms of a substance which have the same atomic number but different mass numbers ?
(b) What is the difference in the atomic structures of such atoms ?

Ans : COMP 2012

(a) Isotopes.
(b) Isotopes are the atoms of the same element which have the same atomic number but different mass numbers. Therefore, they have the same number of electrons and the same number of protons but different numbers of neutrons.

164. (a) Give one difference between a chemical change and a nuclear change.
(b) Copy and complete the following nuclear equations by filling the correct values in the blanks :
${}^{238}_{92}\mathrm{P} \xrightarrow{-\alpha} {}^{\cdots}_{\cdots}\mathrm{P}_1 \xrightarrow{-\beta} {}^{\cdots}_{\cdots}\mathrm{P}_2 \xrightarrow{-\beta} {}^{\cdots}_{\cdots}\mathrm{P}_3$

Ans : MAIN 2018

(a) In a chemical change, atomic number of an element is not changed.
In a nuclear change, atomic number of an element is changed.
(b) ${}^{238}_{92}\mathrm{P} \xrightarrow{-\alpha} {}^{234}_{90}\mathrm{P}_1 \xrightarrow{-\beta} {}^{234}_{91}\mathrm{P}_2 \xrightarrow{-\beta} {}^{234}_{92}\mathrm{P}_3$

165. State an advantage of the recycling of nuclear waste.

Ans : SQP 2012

Using recycling of nuclear waste method, the nuclear products can be re-used or disposed of conveniently. But it is a costly process and need proper facilities.

166. State two uses of X-rays.

Ans : MAIN 2019

X-rays are used :
(i) in detecting flaws and cracks in metal sheets.
(ii) in surgery for the detection of fractures.
(iii) in the custom department for detection of smuggled materials kept in the baggage of passengers at custom posts.

167. When a nucleus undergoes alpha decay, is the product atom electrically neutral ? What about in beta decay?

Ans : SQP 2016

No, in alpha decay, the atomic number decreases by 2, hence, the atom is left with 2 extra orbital electrons. It therefore, has a double negative charge. In beta decay, the atom is left with a net positive charge.

168. How are β-rays emitted from a nucleus while it does not contain electrons ?

Ans : MAIN 2016

β-rays are emitted from the nucleus due to conversion of a neutron into a proton, an electron and anti-neutrino. This electron is emitted from the nucleus in the form of β-rays.

$$\underset{\text{(neutron)}}{{}^{1}_{0}n} \longrightarrow \underset{\text{(proton)}}{{}^{1}_{1}H} + \underset{\substack{\text{(electron)}\\ \text{or}\\ (\beta-\text{particle})}}{{}^{0}_{-1}e} + \underset{\text{(antineutrino)}}{\bar{\nu}}$$

169. A certain nucleus X has a mass number 14 and atomic number 6. The nucleus X changes to ${}_{7}Y^{14}$ after the loss of a particle.
(a) Name the particle emitted.
(b) Represent this change in the form of an equation.

Ans : MAIN 2014

(a) β-particle is emitted.
(b) The required equation is as shown below:

$${}^{14}_{6}X \longrightarrow {}^{14}_{7}Y + {}^{0}_{-1}e$$

Downloaded from www.pdf.tube

170. What do you mean by atomic nucleus? Who discovered it ?

Ans : COMP 2016

In 1911, Ernest Rutherford performed α-ray scattering experiment and proposed that the nucleus is the central part of the atom where entire positive charge and most of the mass of an atom are concentrated.

171. Nuclear reactions have been successfully demonstrated with the following energetic projectiles; neutron, α-particles, protons and γ-rays. Complete the following reactions :

$$^{28}_{13}\text{Al} + ^{1}_{1}\text{H} \longrightarrow ? + ^{1}_{0}n$$

$$^{24}_{12}\text{Mg} + ? \longrightarrow ^{23}_{11}\text{Na} + ^{1}_{1}\text{H}$$

Ans : MAIN 2014

$$^{28}_{13}\text{Al} + ^{1}_{1}\text{H} \longrightarrow ^{28}_{14}\text{N} + ^{1}_{0}n$$

$$^{24}_{12}\text{Mg} + \gamma\text{-rays} \longrightarrow ^{23}_{11}\text{Na} + ^{1}_{1}\text{H}$$

172. A radioactive nucleus $^{A}_{Z}X$ first emits a beta particle and then an alpha particle and the resulting nucleus is represented by $^{P}_{Q}Y$. What are the values of P and Q in terms of A and Z ?

Ans : COMP 2012

The above reaction can be represented as shown below :

$$^{A}_{Z}X \xrightarrow{\beta} {}^{A}_{Z+1}B \xrightarrow{\alpha} {}^{A-4}_{Z+1-2}Y$$

This gives $P = (A-4)$ and $Q = (Z-1)$.

173. What are beta rays and gamma rays?

Ans : SQP 2019

Beta rays (particles) are electrons (with negative charge), but of nuclear origins.
Gamma rays are electromagnetic radiations of very short wavelength emitted from within the nuclei.

174. Explain briefly what change takes place within the nuclei, when beta particles are emitted by a radioactive substance.

Ans : COMP 2019

The emission of 13-particles by the nuclei of a radioactive substance does not change the mass number of the atom but increases its atomic number by one.

e.g. $^{A}_{Z}X \xrightarrow{-\beta} {}^{A}_{Z+1}Y + {}^{0}_{-1}e$

175. Mention any two differences between nuclear energy and chemical energy.

Ans : SQP 2011

(i) The release of nuclear energy is much greater than that of chemical energy for the same mass of substances involved.
(ii) The release of nuclear energy involves the nucleus of the atom while the release of chemical energy involves only the electrons in the outer orbit of the atom.

176. Following equations reflect the nuclear reactions described incompletely. Fill in the gaps in these equations by employing the conservation of masses and the atomic numbers of the reacting species and products.

(a) $^{27}_{13}\text{Al} + ^{4}_{2}\text{He} \longrightarrow ^{30}_{14}\text{Si} + _____$

(b) $^{39}_{19}\text{K} + _____ \longrightarrow ^{42}_{20}\text{Ca} + ^{1}_{1}\text{H}$

Ans : MAIN 2020

(a) $^{1}_{1}\text{H}$

(b) $^{4}_{2}\text{He}$

177. A radioactive nucleus undergoes a series of decays according to the sequence

$$X \xrightarrow{-\beta} X_1 \xrightarrow{-\alpha} X_2 \xrightarrow{-\gamma} X_3$$

If the mass number and atomic number of X_3 are 172 and 69 respectively, what is the mass number and atomic number of X ?

Ans : COMP 2017

Mass number of $X = 176$

Atomic number of $X = 70$

178. What are radioactive substances ? Give two examples of such substances.

Ans : SQP 2017

Radioactive substances are those which have the property of self emission of radiations. Examples: Uranium, Thorium.

179. Can we use aluminium or steel as a target in X-ray production experiment ? If not, why ?

Ans : COMP 2013

The target should be of a material of high atomic weight and high melting point. If the metal is of high melting point, it will not melt due to heat developed due to collision of electrons. High atomic weight metal will emit X-rays of high energy.

NODIA

180. Write the factors on which the rate of decay of a radioactive substance depends and on which it does not depend.

Ans : SQP 2013

The rate of decay of a radioactive substance depends on the ratio of neutron and proton. It does not depend on temperature, pressure and chemical combination.

181. The isotope of $^{238}_{92}\mathrm{U}$ decays by alpha emission to an isotope of thorium (Th). The thorium isotope decays by beta emission to an isotope of Protactinium (Pa). Write down the equations to represent these two nuclear changes.

Ans : MAIN 2010

$$^{238}_{92}\mathrm{U} \xrightarrow{-\alpha} {}^{234}_{90}\mathrm{Th} \xrightarrow{-\beta} {}^{234}_{91}\mathrm{Pa}$$

182. If a person stands between an X-ray tube and a fluorescent screen, what is observed on the screen and why ?

Ans : SQP 2007

If a person stands between an X-ray producing tube and a fluorescent screen, the shadows of the bones are seen on the screen. This is because bones absorb X-rays more than the flesh does.

183. What is background radiation ? How can you detect background radiation ?

Ans : COMP 2021

The radiation which is omnipresent on earth, because of radioactive substances within earth and the cosmic particles in air is called background radiation. It can be detected with the help of Geiger Counter.

184. Can it be concluded from beta decay that electrons exist inside the nucleus ?

Ans : COMP 2014

No, the beta particle although an electron is actually created at the instant of beta decay and ejected at once. It cannot exist inside the nucleus as its de-Broglie wavelength is much larger than the dimensions of the nucleus.

185. A nucleus $^{m}_{n}X$ emits one α-particle and one β -particle. What are the mass number and atomic number of the product nucleus ?

Ans : MAIN 2016

With the emission of an α-particle ($^{4}_{2}\mathrm{H}$) and a β-particle ($^{0}_{-1}e$), the mass number and atomic number of the product nucleus are $(m-4)$ and $(n-1)$ respectively.

186. State charge and mass of (i) α-particle, (ii) β -particle.

Ans : MAIN 2016

(i) The charge on α-particle is $+3.2 \times 10^{-19}$ coulomb and its mass is 6.67×10^{-27} kg (i.e., nearly 4 times the mass of proton).

(ii) The charge on β-particle is -1.6×10^{-19} coulomb and its mass is 9.1×10^{-31} kg.

187. Explain the following : (i) Nucleus, (ii) Nucleons.

Ans : SQP 2013

(i) **Nucleus :** The central core of an atom is called nucleus. The nucleus contains protons and neutrons.

(ii) **Nucleons :** Neutrons and protons are collectively called nucleons.

188. How are X-rays and γ-rays produced ?

Ans : COMP 2013

X-rays are produced when fast moving electrons strike a metal of high atomic weight and high melting point, while γ-rays are produced from nuclei of substances either by artificial or natural disintegrations.

189. Show by equations, the effect on the proton number Z and mass number A of the parent nucleus brought about by the two types of radioactive decay.

Ans : COMP 2013

Let the parent nucleus be X, then

$$^{A}_{Z}X \xrightarrow[\text{emission}]{\alpha-\text{particle}} {}^{A-4}_{Z-2}Y$$

$$^{A}_{Z}Q \xrightarrow[\text{emission}]{\alpha-\text{particle}} {}^{A}_{Z+1}P \text{ (new nucleus)}$$

γ-ray emission : There is no change in the mass number (A) and proton number (Z) of the nucleus of the element.

190. An atomic nucleus denoted by $^{A}_{Z}X$ emits an alpha particle. Write an equation to show the formation of the daughter product.

Ans : MAIN 2019

When an α-particle is emitted from a parent atom $^{A}_{Z}X$, it gives rise to daughter nucleus $^{A-4}_{Z-2}Y$, alpha-particle and some energy.

$$^{A}_{Z}\mathrm{X} \longrightarrow {}^{A-4}_{Z-2}\mathrm{Y} + {}^{4}_{2}\mathrm{He} + \text{energy}$$

Click Here to Buy book on Amazon

Ans : MAIN 2009

α-radiations are positively charged particles with charge $+2e$ and mass $4m_p$, where e is electronic charge (i.e., charge on a proton) and m_p is the mass of a proton. β-radiations are negatively charged particles (i.e., electrons) with charge $-e$ and mass 1/1836 times the mass of a proton. γ-radiations are electromagnetic waves of wavelength in the range 0.001 Å to 0.1 Å.

137. What is the nature of beta particles ? Explain briefly how beta particles are ejected from the nucleus of an atom.

Ans : COMP 2011

Beta particles are fast moving electrons that are emitted from the nucleus of an atom. In the nucleus, a neutron changes into a proton and emits an electron at a high speed at the same time. This electron ejected from the nucleus is called a beta particle.

138. How does a helium atom differ from an alpha particle ?

Ans : COMP 2011

A helium atom is neutral having two electrons in its outer orbit. An alpha particle is a doubly ionised helium nucleus having a positive charge.

139. What will an alpha particle change into when it absorbs : (a) one electron and (b) two electrons?

Ans : SQP 2003

An α-particle consists of two protons and two neutrons. It is like a doubly ionized helium atom ${}^4_2\text{He}$ or He^{++}.

(a) If α-particle absorbs one electron, it changes to a singly ionized helium (He^+).

(b) If α-particle absorbs two electrons, it changes to a helium atom (He).

140. State four properties of X-rays.

Ans : SQP 2003

The following are the properties X-rays :

(i) X-rays do not require any material medium for their propagation.

(ii) X-rays travel in straight lines in vacuum at a speed equal to that of light.

(iii) X-rays are not deflected by electric or magnetic field as these rays contain no charged particles.

(iv) X-rays affect a photographic plate.

141. (i) How does the position of an element change in the periodic table when it emits out a beta particle ?

(ii) What changes occur in the nucleus of radioactive element when it emits gamma radiation ? Give an example.

Ans : MAIN 2019

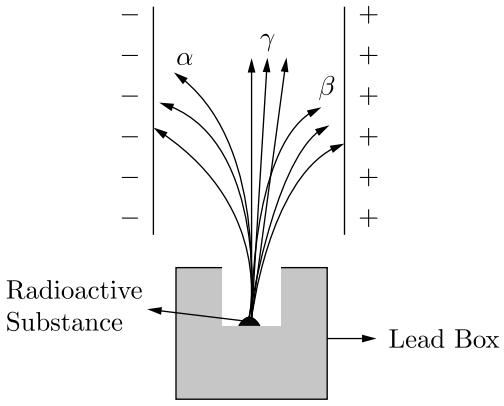
(i) When an element emits a beta particle, a new element is formed with properties similar to those of an element one place later in the periodic table.

(ii) When the nucleus of a radioactive element emits gamma radiation, there is no change inside the nucleus except that its excess energy is released in the form of γ-radiation. ${}^A_Z P^* \rightarrow {}^A_Z P + \gamma$. The star indicates the excited state of nucleus.

142. A scientist wishes to investigate the deflection of particles emitted by a radioactive source. Draw a labelled diagram to show the deflection in an electric field. Explain the direction of the deflection of the emitted particles.

Ans : COMP 2019

The particles emitted by a radioactive source are α, β and γ. β-particles are negatively charged electrons which are attracted to positive plate; α -particles are positively charged particles which are attracted to negative plate and γ-radiations go undivided.



143. (i) Name the different radiations which are emitted by the radioactive substance.

(ii) Are all the radiations mentioned by you, emitted in a single radioactive decay ?

Ans : COMP 2013

(i) Following three radiations are emitted by the radioactive substance :

NODIA

The $^{24}_{11}Na$ nucleus emits a beta particle and changes into Magnesium.

(i) The above process is represented by the equation

$$^{24}_{11}Na \longrightarrow {}^{24}_{12}Mg + {}^{0}_{-1}e$$

(ii) The number 24 is the mass number of the nucleus and 11 is the atomic number.

(iii) $^{24}_{11}Na$ and $^{24}_{12}Mg$ are isobars, i.e., they have same mass number (protons + neutrons) but different atomic number (protons).

200. Name the radiations :

(i) that are used for photography at night.

(ii) used for detection of fracture in bones.

(iii) whose wavelength range is from 100 Å to 4000 Å (or 10 nm to 400 nm).

Ans : MAIN 2013

(i) Infrared radiations.

(ii) X-rays.

(iii) Ultraviolet radiations.

201. The ore of Uranium found in nature contains $_{92}U^{238}$ and $_{92}U^{235}$. Although both the isotopes are fissionable, it is found out experimentally that one of the two isotopes is more easily fissionable.

(i) Name the isotope of Uranium which is easily fissionable.

(ii) Give a reason for your answer.

(iii) Write a nuclear reaction when Uranium 238 emits an alpha particle to form a Thorium (Th) nucleus.

Ans : MAIN 2013

(i) $_{92}U^{235}$

(ii) It readily absorbs thermal neutrons and becomes unstable.

(iii) The reaction is $_{92}U^{238} \longrightarrow {}_{90}Th^{234} + {}_{2}He^{4}$

202. A nucleus $^{A}_{Z}X$ emits an alpha particle followed by γ-emission; thereafter it emits two β-particles to form X_3.

(a) Copy and complete the values of A and Z for X_3

$$^{A}_{Z}X \xrightarrow{-\alpha} X_1 \xrightarrow{-\gamma} X_2 \xrightarrow{-2\beta} \cdots\cdots X_3$$

(b) Out of alpha (α), beta (β) and gamma (γ) radiations-

(i) which radiation is the most penetrating?

(ii) which radiations are negatively charged?

Ans : MAIN 2013

(a) $^{A}_{Z}X \xrightarrow{-\alpha} {}^{A-4}_{Z-2}X_1 \xrightarrow{-\gamma} {}^{A-4}_{Z-2}X_2 \xrightarrow{-2\beta} {}^{A-4}_{Z}X_3$

(b) (i) γ-radiation

(ii) β-radiations

203. A radioactive sample is kept at the centre of a large evacuated sphere. How safe will it be ?

Ans : COMP 2013

For safety, the radiations (α, β and γ) emitted by the radioactive sample should not come out of the sphere. α-particles have least penetrating power than all other radiations, therefore, the walls of the sphere easily stops them. β-particles will not be stopped by the walls and there will be no absorption of β-particles inside the sphere as the air has been withdrawn from it. Some safety is obtained if the sphere is large because beta particles reaching out of the sphere will depend upon the radius of the sphere. γ-radiations are also not absorbed by the walls. Thus, for safety, the container should have lead walls and it should not be evacuated. The air will help in absorbing the radiations.

NODIA

204. Why do the harmful effects arise due to radioactivity? What are their consequences ?

Ans : COMP 2011

The harmful effects arise due to radioactivity because these radiations break the molecular bonds in the cells of the body and get absorbed and thereby disturb the normal functioning of the tissue. The consequences are: (i) burns, (ii) leukaemia (cancer of blood), (iii) sterility (inability to produce children), (iv) resistance to normal diseases due to less immunity, (v) abnormalities in children, (vi) genetic defects carried to the next generation through the parents, etc.

205. What happens to the position of an element in the periodic table when it emits

(i) α-particle

(ii) β-particles

(iii) γ-radiations ?

Ans : SQP 2011

(i) When α-particle is emitted, its mass number decreases by 4 and charge number by two. Its position changes to two positions earlier.

(ii) When β-particle is emitted atomic number increases by 1, therefore, its position advances by 1.

(iii) When γ-radiations are emitted there is no change in the atomic number, hence there is no change in position.

$^{2}_{1}D$ $^{3}_{1}T$

State how these symbols show that they are isotopes of hydrogen.

Ans :

(i) (b) 1 proton only

(ii) The atomic number of both symbol is same i.e. 1 so it is the isotopes of hydrogen.

241. Carbon-13 and carbon-14 are isotopes of carbon. Nuclei of carbon-13 and carbon-14 can be represented by these symbols

$^{14}_{6}C$ and $^{14}_{6}C$

(i)

	number of neutrons in the nucleus	**number of electrons in orbit around the nucleus**
Carbon-13		
carbon-14		

(ii) Complete the sentences below about ions.
Atoms may form positive ions by ..... electrons. The electrons involved in forming positive ions are the ..... electrons. (absorbing/ gaining/ inner/ losing/ outer)

Ans :

(i)

	number of neutrons in the nucleus	**number of electrons in orbit around the nucleus**
Carbon-13	7	8
Carbon-14	8	6

(ii) losing, outer.

242. Wood contains a lot of carbon, most of which is the isotope carbon-12 or $^{12}_{6}C$.Wood also contains a small fraction of the radioactive isotope carbon-14 or $^{14}_{6}C$.The half-life of carbon-14 is 5700 years. Carbon-14 decays to nitrogen-14.
While a tree is alive, it has a constant fraction of carbon-14. But, after the tree dies, this fraction decreases because of radioactive decay. Measurement of this fraction allows us to work out the age of very old samples of wood.

(i) Calculate the number of neutrons in a nucleus of carbon-12

(ii) *A* scientist compares two samples of wood: one from a recently felled tree, the other from an older piece of wood. After corrections to account for the background count and mass of the samples, the scientist finds the count rate from the old wood is four times lower than the count rate from the new wood. Calculate the age of the old wood.

Ans :

(i) 6

(ii) The count rate is a quarter, so two half-lives have passed age $= 2 \times 5700 = 11400$ years.

243. The teacher obtained these results in her experiment.

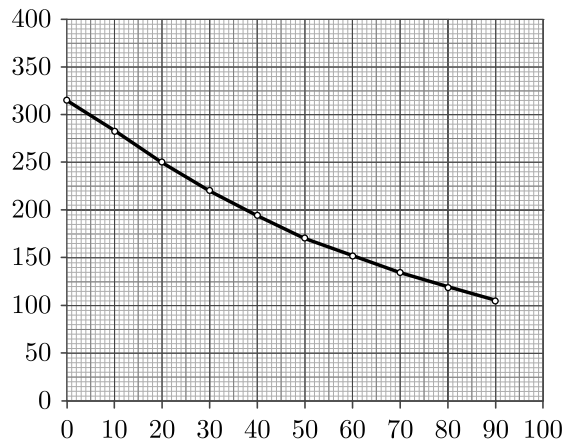
Count rate/Bq	**Time/s**
320	0
283	10
250	20
221	30
195	40
172	50
152	60
135	70
119	80
105	90

(i) Plot a graph of count rate (y-axis) against time (x-axis)

(ii) Calculate how long it takes for the count rate to fall below 10 Bq.

Ans :

(i)



(ii)

1/2 lives	**count rate**
0	320

Downloaded from www.pdf.tube

BETTER THAN BOOK IN THE MARKET

Why students are choosing this book 👉

School teachers already use this content to set papers.

Still not sure?

- 👉 Match this PDF with your question papers
- 👉 See the similarity yourself

Why does this happen?

- ✓ Teachers have its PDF & Word files
- ✓ Easy access
- ✓ Direct copy-paste questions
- ✓ Same pattern followed

Don't miss out—get the advantage today!

Ans : SQP 2014

In a nuclear reaction following conservation laws are followed :

(i) Conservation of momentum, i.e. the total momentum of the interacting particles before and after the nuclear reaction remains the same.

(ii) Conservation of charge, i.e. total sum of the atomic numbers of the particles before and after the nuclear reaction remains the same, e.g., ${}^{9}_{4}\text{Be} + {}^{4}_{2}\text{He} \longrightarrow {}^{12}_{6}\text{C} + {}^{1}_{0}n$

Total charge before reaction $= 4 + 2 = 6$
Total charge after reaction $= 6 + 0 = 6$

(iii) Conservation of nucleons, i.e. total number of nucleons more precisely baryons remains conserved, e.g.,
Total number of nucleons before reaction $= 9 + 4 = 13$
Total number of nucleons after reaction $= 12 + 1 = 13$

(iv) Conservation of energy, i.e. total energy (rest mass energy + kinetic energy) of a particle before and after the reaction remains the same.

211. Describe briefly, two properties each of alpha particles and gamma radiations.

Ans : COMP 2017

Properties of alpha-particles and gamma radiations are as follows:

	Alpha Particles	**Gamma Radiations**
(i)	These are Helium nuclei (${}^{4}_{2}\text{He}$) with 2 protons and 2 neutrons bound together.	These are electromagnetic radiations of very short wavelength.
(ii)	Being charged particles, they are deflected by both electric and magnetic fields.	As they do not carry any charge, they are not deflected by electric and magnetic fields.

212. What are radio-isotopes ? Name four uses of these isotopes.

Ans : SQP 2018

Radio-isotopes are the isotopes which are radioactive, e.g. ${}^{14}_{6}\text{C}$ is a radio-isotope of carbon, ${}^{22}_{11}\text{Na}$ and ${}^{24}_{11}\text{Na}$ are the radio-isotopes of sodium. These radio-isotopes have identical chemical properties. The it main advantage of radio-isotopes is that their position can be detected very easily by the radiation which they emit.

(i) Radio-isotope as a tracer is used in medicine, agriculture and industry.
(ii) Therapeutic use in medicine.
(iii) Testing industrial products.
(iv) Carbon-14 dating.

213. (i) A thorium isotope ${}^{223}_{90}\text{Th}$ undergoes an α -decay and changes into Radium. What is the atomic number and mass number of the radium produced?

(ii) If the radium undergoes a further disintegration and emits two beta particles, represent this reaction in the form of an equation.

(iii) What is the source of energy released during the decay ?

Ans : MAIN 2018

(i) The atomic number is $90 - 2 = 88$ and the mass number is $223 - 4 = 219$.

(ii) The required scheme of decay is as below :
${}^{219}_{88}\text{Ra} \longrightarrow {}^{219}_{90}\text{Th} + 2\,{}^{0}_{-1}e$

(iii) The difference in the mass of the reactants and the products is converted into energy according to Einstein's mass energy relation $E = mc^2$.

214. An element P disintegrates by α-emission and the new element suffers two further disintegrations, both by β-emission to form an element Q. Check if P and Q are Isotopes.

Ans : MAIN 2018

When an element P disintegrates, the new be P' , then ${}^{A}_{Z}P \longrightarrow {}^{A-4}_{Z-2}P' + {}^{4}_{2}\text{He}$
Now, P' disintegrates twice, therefore, the new element Q is formed as

$${}^{A-4}_{Z-2}P' \longrightarrow {}^{A-4}_{Z-2}P^{n} + {}^{0}_{-1}e \longrightarrow {}^{A-4}_{Z}Q + {}^{0}_{-1}e$$

Clearly, ${}^{A}_{Z}P$ and ${}^{A-4}_{Z}Q$ have the same atomic number but different atomic weight and hence are isotopes.

215. Describe briefly the structure of an atomic nucleus giving an example.

Ans : SQP 2008

A nucleus is made up of protons and neutrons. The number of protons in the nucleus is called the atomic number represented by Z. The number of neutrons in the nucleus is known as neutron number represented by N. Both protons and neutrons in the nucleus are called as nucleons.

NODIA

226. The following are the different types of radiation: alpha (α), beta (β), gamma (γ), infrared, radio, ultraviolet, visible

(a) Which radiations are not electromagnetic radiations ?
(b) Which radiation is the most penetrating ?
(c) Which radiation has the longest wavelength ?
(d) Which radiation consists of particles that are the same as $^4_2$He nuclei ?

Ans : SQP 2010

(a) Alpha and beta both are not electromagnetic radiations.
(b) Gamma radiation is the most penetrating.
(c) Radio waves has the longest wavelength.
(d) Alpha radiation consists of particles that are the same as $^4_2$He nuclei.

227. What do you mean by radioactivity? What type of radiations are emitted? Explain briefly the nature of these radiations.

Ans : MAIN 2016

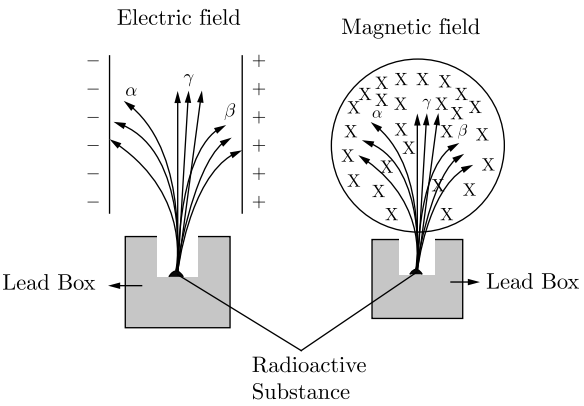
Radioactivity is the process of spontaneous disintegration of the atomic nuclei with the emission of particles from within the nuclei of atoms.

Experiment investigations reveal that the radiations emitted by radioactive elements are of three types :

The first type of radiations with least penetrating power was named as Alpha (α) rays.

The second type of radiations with comparatively larger penetrating power was called Beta (β) rays. The third type of radiations with maximum penetrating power was called Gamma (γ) rays. In 1903 Rutherford studied experimentally the nature of the radiations emitted by radioactive block substances. He found that when these radiations are subjected to an electric field provided by two plates as shown in the figure, the α-rays are deflected through smaller angles towards the negative plate.

The β-rays are deflected through larger angles towards the positive plate and the γ-rays remain undeflected. As opposite charges attract each other, it was concluded that α-rays consist of a stream of positively charged particles whereas β-rays consist of a stream of negatively charged particles, γ-rays go undeflected, they could be waves or particles. Further investigations showed that γ-rays have no charge and no mass, therefore considered to be electromagnetic waves. Similarly, when these radiations were subjected to a magnetic field perpendicular and into the plane of the paper, they separate into three distinct constituents as shown in the figure. The direction of deflection in magnetic field was given by Fleming's left-hand rule.



228. Write few properties of α-rays, β-rays and γ-radiations.

Ans : MAIN 2020

The properties of α-rays, β-rays and γ-radiations are as follows:

Property	**α-Rays**	**β-Rays**	**γ-Rays**
Nature	stream of positively charged particles, i.e. helium nuclei.	stream of negatively charged particles, i.e. fast moving electrons.	electro-magnetic waves.
Charge	positive charge $(+2e)$ $+3.2 \times 10^{-19}$ C	negative charge $(-e)$ -1.6×10^{-19} C	no charge
Rest mass	4 times the mass of proton i.e., 6.64×10^{-27} kg	mass of electron i.e., 9.1×10^{-31} kg	no mass
Speed	1.4×10^7 ms^{-1} to 2.1×10^7 ms^{-1}	90% of the speed of light (in vacuum) i.e. 2.7×10^8 ms^{-1}	3×10^8 ms^{-1}
Ionising power	Maximum (100,00 times of γ)	less than α (100 times of γ)	minimum
Penetrating power	small (3–8 cm in air)	large (1 mm of lead or ~ 5 mm of Al)	very large (~ 30 cm of iron)

Click Here to Buy book on Amazon

$$B_{82}^{208} \xrightarrow{\beta} C_{83}^{208}$$

The composition of B is 83 protons and 126 neutrons.

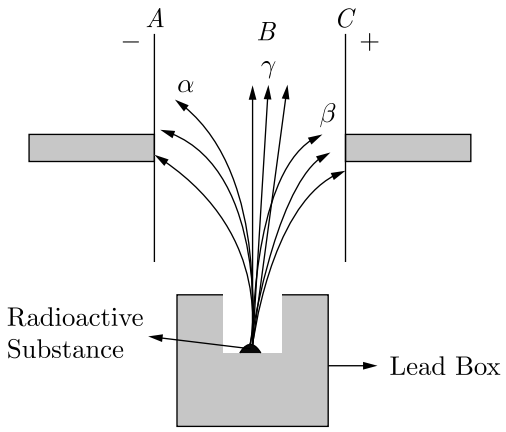
(iii) Mass number of $A = 212$.

(iv) No.

222. Radiations given out from a source when subjected to an electric field in a direction perpendicular to their path are shown below in the diagram. The arrows show the path of the radiation A, B and C. Answer the following questions in terms of A , B and C.

(i) Name the radiation B which is unaffected by the electrostatic field.

(ii) Why does the radiation C deflect more than A ?



(iii) Which among the three causes the least biological damage externally ?

(iv) Name the radiation which is used in carbon dating.

Ans : SQP 2018

(i) Gamma radiation.

(ii) Because it is lighter than A.

(iii) Alpha (A).

(iv) Carbon-14.

223. An isotope of uranium has a mass number 235 and atomic number 92.

(i) What is the number of electrons in the neutral atom of this isotope ?

(ii) What is the number of protons and number of neutrons in its nucleus ?

(iii) Do all isotopes have the same number of neutrons?

(iv) What is the number of protons in $^{238}_{92}U$?

Ans : SQP 2019

(i) Given; $A = 235$, $Z = 92$. Atomic number $Z =$ Number of protons = Number of electrons $= 92$.
Therefore, a neutral atom of uranium-235 has 92 electrons.

(ii) The number of protons $= Z = 92$. The number of neutrons $= A - Z = (235 - 92) = 143$.

(iii) Isotopes of an element have the same number of protons but different number of neutrons since their mass numbers are different.

(iv) Uranium-238 is an isotope of uranium-235, therefore, it has the same number of protons as that in uranium-235, i.e., 92.

224. A mixture of radioactive substances gives off three types of radiations.

(i) Name the three types of radiations.

(ii) Name the radiations which are charged.

(iii) Name the radiation similar in nature to cathode rays.

(iv) Name the radiation similar in nature to X -rays.

Ans : COMP 2017

(i) The three types of radiations are :
(1) alpha,
(2) beta and
(3) gamma

(ii) Alpha and beta radiations are charged.

(iii) Beta radiation is similar in nature to cathode rays.

(iv) Gamma radiation is similar in nature to X -rays.

225. A mixture of radioactive substances gives off three types of radiations.

(i) Name the radiation which is deviated most in a magnetic field.

(ii) Name the radiation which is not affected by an electric field.

(iii) Name the radiation which has the maximum penetrating power.

(iv) Name the radiation which has the highest ionising power.

Ans : SQP 2017

(i) Beta radiation is deviated most in a magnetic field.

(ii) Gamma radiation is not affected by an electric field.

(iii) Gamma radiation has the maximum penetrating power.

(iv) Alpha radiation has the highest ionising power.

NODIA

Download NODIA App for All Sample Papers PDFs

The total number of nucleons $(Z+N)$ is called the mass number and represented by A. For example in $^{238}_{92}U$, i.e. in Uranium element the mass number (total number of nucleons) $A = 238$ and atomic number $Z = 92$ the number of neutrons $N = A - Z = 238 - 92 = 146$.

216. State the kind of nuclear reaction taking place in a nucleus during the emission of a β-particle.

Ans : SQP 2010

In the process of emission of a β-particle from the nucleus, a neutron changes into a proton by emitting a beta particle and anti-neutrino as follows : $^{1}_{0}n \rightarrow {}^{1}_{1}p + {}^{0}_{-1}e + \bar{v}$. Hence, in the nucleus, the number of neutrons decreases by 1 with the emission of a β-particle and the number of protons increases by one. So the sum of protons and neutrons, i.e., atomic mass remains the same but the atomic number increases by one.

217. A radioactive nucleus undergoes a series of decays according to the sequence :

$$X \xrightarrow{\beta} X_1 \xrightarrow{\alpha} X_2 \xrightarrow{\alpha} X_3$$

If the mass number and atomic number of X_3 are 172 and 69 respectively, what is the mass number and atomic number of X ?

Ans : COMP 2008

$$X \xrightarrow{\beta} X_1 \xrightarrow{\alpha} X_2 \xrightarrow{\alpha} X_3$$

If X_3 has At. No. 69 and Mass No. 172.

$$^{172}_{69}X_3 + \alpha \longrightarrow {}^{176}_{71}X_2$$

$$^{176}_{71}X_2 + \alpha \longrightarrow {}^{180}_{73}X_1$$

$$^{180}_{73}X_1 + \alpha \longrightarrow {}^{180}_{72}X$$

[As emission of α decreases (As emission of β increases At. No. by 1 and At. No. by 2 and Mass No. by 4) no change in Mass No.]
X has At. No. 72, Mass No. 180.

218. How is a cathode ray beam affected while passing through (i) a magnetic field, (ii) an electric field ?

Ans : COMP 2008

(i) A cathode ray beam while passing through a magnetic field is deflected in a direction normal to both the direction of magnetic field and the direction of its travel, as given by Fleming's left hand rule.
(ii) A cathode ray beam while passing through an electric field is deflected towards the positive plate (i.e., towards higher potential).

219. From α, β and γ, name the one :
(i) Which has the maximum penetrating power ?
(ii) Which has the maximum ionising power ?
(iii) Which travels with the speed of light ?

Ans : MAIN 2008

(i) γ-rays have the maximum penetrating power.
(ii) α-particles have the maximum ionising power.
(iii) γ-rays travel with the speed of light.

FOUR MARKS QUESTIONS

220. (i) What is nuclear energy?
(ii) After emission of a nuclear radiation, the atomic number of the daughter nucleus increases by 1. Identify the nuclear radiation.
(iii) Write a nuclear reaction indicating the nuclear change mentioned in (ii).
(iv) What is the special name given to the parent and daughter nucleus when this radiation is emitted?

Ans : SEM-II 2022

(i) Nuclear energy is the energy released during the transformation of nuclei to another nuclei.
(ii) The atomic number of the daughter nucleus increases by 1 in the β-decay.
(iii) Nuclear reaction for β-decay

$$^{1}_{0}n \longrightarrow {}^{1}_{1}p + \underset{(\beta-\text{particle})}{{}^{0}_{-1}e}$$

(iv) Parent nucleus is known as neutron and daughter nucleus is known as proton.

221. An atomic nucleus A is composed of 84 protons and 128 neutrons. The nucleus A emits an alpha particle and is transformed into a nucleus B.
(i) What is the composition of B?
(ii) The nucleus B emits a beta particle and is transformed into a nucleus C. What is the composition of C ?
(iii) What is mass number of the nucleus A ?
(iv) Does the composition of C change if it emits gamma radiations ?

Ans : COMP 2020, 2015

(i) The reaction is as follows :

$$A^{212}_{84} \xrightarrow{\alpha} B^{208}_{82}$$

The composition of B is 82 protons and 126 neutrons.
(ii) The reaction is as follows :

Downloaded from www.pdf.tube

Property	α-Rays	β-Rays	γ-Rays
Photographic plate	affect photographic plate and bring about chemical changes	affect photographic plate and produce fluorescence	affect photographic plate

NUMERICAL QUESTION

229. What mass of ice at 0°C added to 2.1 kg water, will cool it down from 75°C to 25°C? Given Specific heat capacity of water = 4.2 Jg^{-1} $°C^{-1}$, Specific latent heat of ice = 336 Jg^{-1}.

Ans : SQP 2025

$$\text{Heat lost} = \text{heat gained}$$
$$\text{m c } \Delta\text{t} = \text{m 1} + \text{m c } \Delta\text{t}$$
$$2100 \times 4.2 \times (75-25) = \text{m} \times 336 + \text{m}$$
$$\times 4.2 \times (25-0) \text{ ... (each side 1 M)}$$
$$2100 \times 4.2 \times 50 = \text{m} \times 4.2(80+25)$$
$$2100 \times 50 = 105 \times \text{m}$$
$$\text{m} = \frac{(2100 \times 50)}{105}$$
$$= \frac{(100 \times 50)}{5}$$
$$\text{m} = 1000 \text{ g}$$

230. Complete and rewrite the following nuclear reaction by filling the blanks.

$$^{235}_{...}\text{U} \longrightarrow {}^{...}_{90}\text{Th} + {}^{4}_{2}\text{He}$$

Ans : SEM-II 2022

General equation for α-decay is

$${}_{Z}X^{A} \xrightarrow{\alpha-\text{particle}} \underset{\text{(Thorium)}}{{}_{Z-2}Y^{A-4}} + \underset{(\alpha-\text{particle})}{{}^{4}_{2}\text{He}}$$

$$Z_{\text{LHS}} = Z_{\text{RHS}}$$
$$x = 90 + 2$$
$$x = 92$$
$$A_{\text{LHS}} = A_{\text{RHS}}$$
$$235 = y + 4$$
$$235 - 4 = y$$
$$231 = y$$

Now, compete reaction is

$$^{235}_{92}\text{U} \longrightarrow {}^{231}_{90}\text{Th} + {}^{4}_{2}\text{He}$$

231. An element ${}_{z}S^{A}$ decays to ${}_{85}R^{222}$ after emitting 2α particles and 1β particle. Find the atomic number and atomic mass of the element S.

Ans : SQP 2016

The decay will follow the following sequence :

$${}_{z}S^{4} \xrightarrow{\alpha} {}_{z-2}P^{A-4} \xrightarrow{\alpha} {}_{z-4}Q^{A-8} \xrightarrow{\beta} {}_{z-3}R^{A-8}$$

Therefore, we have $Z-3=85$ or $Z=85+3=88$
And $A-8=222$ or $A=222+8=230$
$Z=88, A=230$

232. A radioactive nucleus undergoes a series of decays according to the sequence :

$$X \xrightarrow{\beta} X_1 \xrightarrow{\alpha} X_2 \xrightarrow{\alpha} X_3$$

If the mass number and atomic number of X_3 are 172 and 69 respectively, what is the mass number and atomic number of X ?

Ans : MAIN 2013

$$X \xrightarrow{\beta} X_1 \xrightarrow{\alpha} X_2 \xrightarrow{\alpha} X_3$$

Due to emission of one β particle from a radioactive nucleus ${}^{m}_{n}X$, atomic number of product nucleus X_1 increases by 1 and mass number remains unchanged, i.e. ${}^{m}_{n+1}X_1$ then due to emission of two α particles product nuclei are X_2 and X_3. The atomic number of X_3 decreases by 4, i.e. becomes $(n+1)-4$ and mass number decreases by 8, i.e. becomes $m-8$, i.e.

$$(n+1)-4 = 69$$
$$n-3 = 69$$
$$n = 72$$

Now , $m-8=172$

and $m=172+8$

$m=180$

Therefore, ${}^{180}_{72}X \xrightarrow{\beta} {}^{180}_{73}X_1 \xrightarrow{\alpha} {}^{176}_{71}X_2 \xrightarrow{\alpha} {}^{172}_{69}X_3$

233. How many alpha and beta particles are emitted when uranium nucleus ${}^{238}_{92}\text{U}$ decays to lead ${}^{206}_{82}\text{Pb}$?

Ans : COMP 2005

Let $x=$ number of α-decays and $y=$ number of β-decay in the decay of ${}^{238}_{92}\text{U}$ to ${}^{206}_{82}\text{Pb}$.
We know that during the α-decay, the product nucleus has a mass number 4 less and atomic number 2 less than of the parent nucleus. During β-decay, mass number remains constant but atomic number increases by 1.

Therefore, $206 = 238 - 4x$ ...(1)

and $82 = 92 - 2x + y$ ...(2)

NODIA

From equation (1), we have

$$4x = 238 - 206$$

$$4x = 32$$

$$x = 8$$

Putting this value of x in (2), we have

$$82 = 92 - 2 \times 8 + y$$

$$y = 82 + 16 - 92$$

$$= 98 - 92 = 6$$

Number of α-particles emitted $= 8$
Number of β-particles emitted $= 6$

234. How many alpha and beta particles are emitted when Uranium nucleus $^{238}_{92}\text{U}$ decays to Lead $^{206}_{82}\text{Pb}$?

Ans : SQP 2005

Due to an alpha $^{4}_{2}\text{He}$ decay, the mass number of the new element formed decreases by 4 and atomic number decreases by 2.

i.e., number of α-decays $= \dfrac{238 - 206}{4}$

$$= \frac{32}{4} = 8$$

This would give atomic number Z

$$= 92 - (8 \times 2)$$

$$= 92 - 16 = 76$$

Due to a beta $(^{0}_{-1}e)$ decay, the atomic number increases by 1 and mass number remains the same.
Therefore, number of β decays $= 82 - 76 = 6$

235. In the given nuclear reaction :
$A + B \rightarrow C + D +$ Energy, the masses of A, B, C and D are 5×10^{-27} kg 2×10^{-27} kg, 3×10^{-27} kg and 1.9×10^{-27} kg respectively. Calculate the energy released in the process.

Ans : COMP 2008

Mass converted into energy, Δm

$$= \text{Sum of masses } (A + B)$$

$$- \text{Sum of masses } (C + D)$$

$$\Delta m = (5 \times 10^{-27} + 2 \times 10^{-27})\,\text{kg}$$

$$-(3 \times 10^{-27} + 1.9 \times 10^{-27})\,\text{kg}$$

$$= (7 - 4.9) \times 10^{-27}$$

$$\Delta m = 2.1 \times 10^{-27}\,\text{kg}$$

We know that energy,

$$E = \Delta m c^2$$

$$E = 2.1 \times 10^{-27} \times (3 \times 10^{8})^2$$

$$E = 2.1 \times 10^{-27} \times 9 \times 10^{16}$$

$$= 1.89 \times 10^{-10}\,\text{J}$$

236. What is the ratio of 1 kW h to 1 MeV ?

Ans : MAIN 2013

As We know that,

$$1\text{ kW h} = 1000\,\text{W} \times (60 \times 60)\,\text{s}$$

$$= 3.6 \times 10^{6}\,\text{J}$$

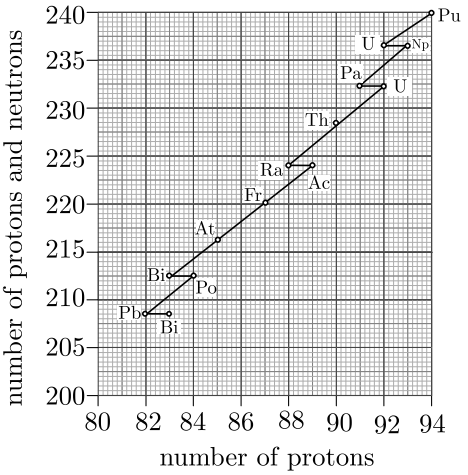
$$1\text{ MeV} = 1.602 \times 10^{-13}\,\text{J}$$

$$\frac{1\text{kW h}}{1\text{ Me V}} = \frac{3.6 \times 10^{6}\,\text{J}}{1.602 \times 10^{-3}\,\text{J}}$$

$$= 2.25 \times 10^{19}$$

CASE BASED QUESTION

237. Plutonium-241 is a radioisotope that eventually decays to the stable isotope bismuth-83.
All the steps in this sequence of decays are shown on the diagram. The symbols of the elements are included in the diagram. The table links the chemical symbols for the elements to their names.



Element	Symbol
plutonium	Pu
neptunium	Np
uranium	U
protactinium	Pa
thorium	Th
actinium	Ac

Click Here to Buy book on Amazon

radium	Ra
francium	Fr
astatine	At
polonium	Po
bismuth	Bi
lead	Pb

(i) Use the information in the diagram to describe the isotopes of thorium and francium in the form shown above.
(ii) Which particle is emitted in this decay of polonium to lead ?
(iii) Construct an equation to show the decay of $^{213}_{84}Po$.

Ans :

(i) $^{229}_{90}$Th and $^{221}_{87}$Fr

(ii) alpha particle

(iii) $^{213}_{84}Po \rightarrow {}^{209}_{82}Pb + {}^{4}_{2}He$

238. A teacher sets up an experiment to show some students how far beta particles travel in air. Figure shows some of the equipment she uses.

(i) State the scientific name for the radioactivity detector shown in Figure
(ii) State two precautions the teacher must take to protect herself from the effects of radioactivity

Ans :

(i) Geiger-Muller tube
(ii) keep a safe distance point the source away from people handle the source with tongs/at a distance limit exposure time/return source to store asap use shielding use of gloves use of mask protective clothing wear a film badge/ monitor.

239. The graph (fig A) illustrates the correlation between the number of protons (x-axis) and the number of neutrons (y-axis) for elements A, B, C, D and E in the periodic table. These elements are denoted by the letters rather than their conventional symbols. When the element C, depicted in the graph, undergoes radioactive decay, it releases radioactive rays. When these rays are directed **into the plane of the paper** in the presence of a magnetic field, as indicated in the fig B, they experience deflection, causing them to move upwards.

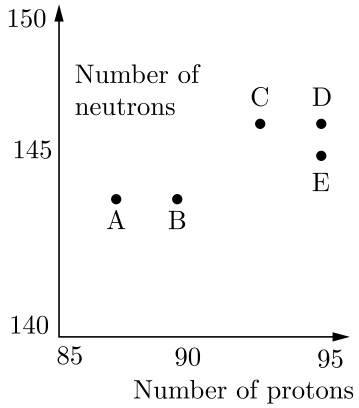


Figure (A)

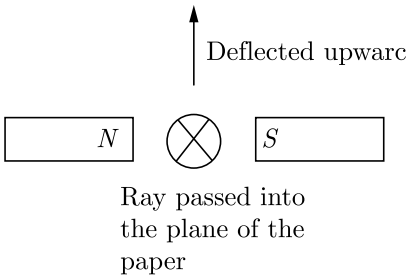


Figure (B)

(i) Name the radioactive radiations emitted by the element C.
(ii) Identify the daughter element from the graph.
(iii) Name the law used to identify the radioactive radiations emitted by the element.

Ans : SQP 2025

(i) Beta
(ii) E
(iii) Flemings left hand rule

240. The nucleus of a hydrogen atom can be represented by this symbol:

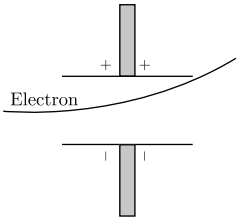
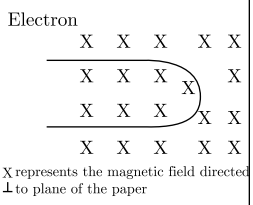
$$^{1}_{1}H$$

(i) The symbol shows that the nucleus consists of
(a) 1 proton and 1 neutron
(b) 1 proton only
(c) 1 neutron only
(d) 1 neutron and 1 electron.
(ii) Two other isotopes of hydrogen are deuterium D and tritium T. Their nuclei can be represented by these symbols:

Downloaded from www.pdf.tube

206. In what ways are the effect produced by electric and magnetic fields produced on an electron beam different ?

Ans : MAIN 2019

	Effect of electric field	**Effect of magnetic field**
(a)	The electric field exerts a force on the electrons in a direction opposite to the electric field.	It exerts a force on the electron beam perpendicular to both the magnetic field and direction of motion.
(b)	The path of electron beam is parabolic as shown : 	The path of the electron beam in the magnetic field is circular :  X represents the magnetic field directed ⊥ to plane of the paper
(c)	It changes both the kinetic energy and momentum of the electrons.	It changes the momentum but has no effect on the kinetic energy of electrons.
(d)	Electric field exerts a force whatever be the direction of motion of electrons.	Magnetic field exerts a force of the electrons move in the direction of magnetic field.

207. What do you mean by background radiations? Mention its four possible sources. In the experiments involving measurements of radioactivity how can the correction be applied ?

Ans : COMP 2019

Background radiation is the radiation present in the atmosphere at any place even when there is no radioactive source in the vicinity.

Its possible sources are :

(i) cosmic radiation (mostly proton showers) coming from outer space,

(ii) rocks in the earth containing traces of radioactive substances,

(iii) naturally occurring radioisotopes,

(iv) artificial radioisotopes,

(v) products from nuclear explosions. (Any four)

Background radiation at a place is found to vary considerably which shows its random nature. In all experiments involving measurements in radioactivity, the average background count over a certain time interval is measured by the counter, (e.g., Geiger counter) and subtracted from experimental values of counts recorded.

208. Which is the first nuclear reaction ? Who discovered it and when ? What was the objective of this experiment?

Ans : COMP 2014

$$\underset{\text{Nitrogen}}{{}^{14}_{7}\text{N}} + \underset{\text{Helium}}{{}^{4}_{2}\text{He}} \longrightarrow \underset{\text{Oxygen}}{{}^{17}_{8}\text{O}} + \underset{\text{Proton}}{{}^{1}_{1}\text{H}}$$

In 1919, Ernest Rutherford performed the first successful experiment in which nitrogen was converted into oxygen when nitrogen was bombarded by α-particles emitted by radioactive element radium. The objective of this experiment was to study whether the nuclear transformations are possible. This experiment was a path breaking experiment showing that one atom can be converted into another.

209. (a) A thorium isotope ${}^{233}_{90}\text{Th}$ undergoes an α -decay and changes to radium. What is the atomic number and mass number of radium produced ?

(b) If the radium undergoes a further disintegration and emits two β-particles, represent the reaction in the form of an equation.

(c) What is the source of energy released during the decay ?

Ans : MAIN 2016

(a) ${}^{233}_{90}\text{Th} \xrightarrow{-\alpha} {}^{4}_{2}\text{H} + {}^{229}_{88}\text{Pa}$

Atomic number and mass number of radium are 88 and 229 respectively.

(b) ${}^{229}_{88}\text{Ra} \longrightarrow {}^{0}_{-1}e + {}^{229}_{89}X$

${}^{229}_{89}X \longrightarrow {}^{0}_{-1}e + {}^{229}_{90}\text{Th}$

Where X has atomic and mass number as 89 and 229 respectively. After emission of two β-particles, we have thorium with atomic number 90 and mass number 229.

(c) Some mass of nucleus is converted into energy according to mass energy equivalence relation.

$$E = mc^2$$

210. Which physical parameters are conserved in a nuclear reaction?

NODIA

1	160
2	80
3	40
4	20
5	10

It takes 5 half-lives so $5 \times 56 = 280\, s$

244. Beryllium-9 is a stable isotope of beryllium.

(i) State the meaning of the term stable.

(ii) Beryllium-9 has an atomic number of 4 and a mass number of 9. A nucleus of this isotope can be described using this symbol.

$$^{9}_{4}\text{Be}$$

What is the number of neutrons in this nucleus ?

Ans :

(i) The meaning of the stable term is that the element does not emit radiation or undergo radioactive decay.

(ii) 5

245. The half-life of strontium-90 is 29 years. The table gives some information about how the mass of a sample of strontium-90 changes with time.

Mass of strontium-90 in g	**Time in years**
1600	0
.....	29
400	.....

Ans :

mass in g	**time in days**
1600	0
800	29
400	58

Click Here to Buy book on Amazon

Visit :
www.pdf.tube

Download PDFs For :

- ✓ Chapterwise Question Bank
- ✓ JEE NEET Foundation
- ✓ Primary Classes Worksheets
- ✓ Olympiad Guide
- ✓ Sample Papers
- ✓ Previous Year Papers
- ✓ Previous JEE Papers
- ✓ Previous NEET Papers

NODIA

Nodia Editions LLP
125, Sector 6, Vidhyadhar Nagar, Jaipur 302039

MRP ₹ 470.00